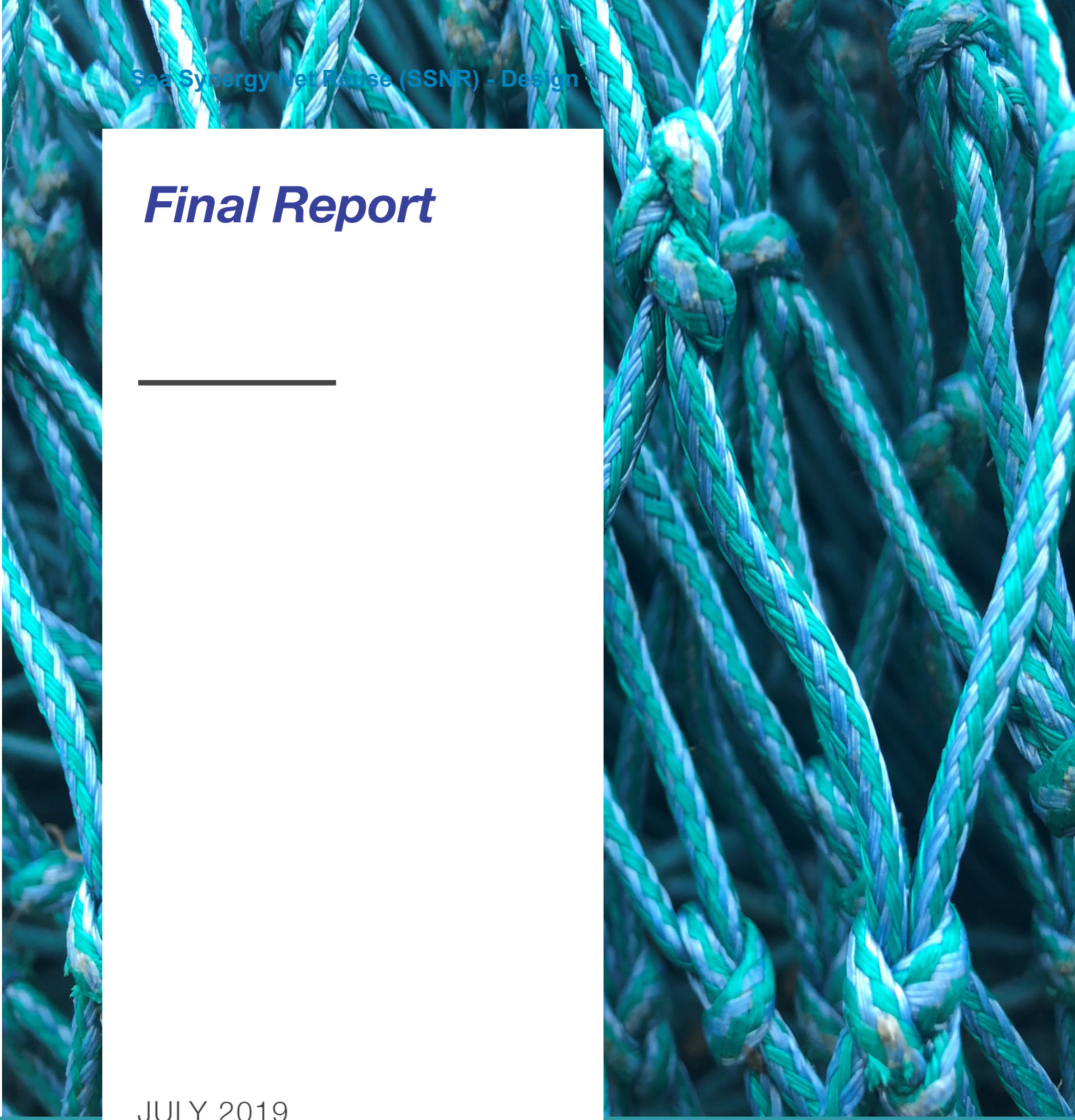


Final Report

JULY 2019

Sea Synergy

Ireland's Seafood Development Agency

Sea Synergy Net Reuse (SSNR) - Design

Solutions to the challenging problem of marine plastic waste could equally be found in the creative imagination of a 12-year-old or the vast experience of an 80-year-old."

1.REPORT SUMMARY

The need for this research project stemmed from an awareness of the current disposal mechanisms for net offcuts created as a by-product of the net manufacturing industry.
With 10 net manufacturers at work throughout Ireland this off cut material is substantial is size and so value. Due to the limited quantities and size of individual pieces it is not deemed useful within the net construction process and so is disposed of. Several net manufacturers have systems in place whereby the off cuts are donated to local arts-led projects the remaining manufacturers have no option but to dispose of these offcuts to landfill.

The value of this current research into net offcuts is in developing marketable products, capable of being constructed via small enterprise within coastal communities, thus adding value to the off-cut material and increasing economic opportunity within the fishing community. To deliver on the these requirements the project proposed by Sea Synergy included a co-design process with both community groups and youth groups, based on the Pcr praxis developed by Dr. Anita Mckeown and trialled previously in situated arts practice.

This includes engaging with local community groups to first assess the impact of fishing net waste material and the current level of understanding of the problem within the communities. This then leads to community and youth design and innovation workshops to begin the process of designing and testing suggested products for saleability and market value. Inherent within the methodology used (the Pcr praxis) to analyse the issue of net offcuts and the production of new products is the concept of the circular economy.

The Pcr praxis was developed with a toolkit to enable a life cycle analysis of processes and products, interweaving issues of sustainability and resource efficiency from the concept and planning stages through to the production and implementation phase.
Over the course of ten months the project delivered the following number of events.

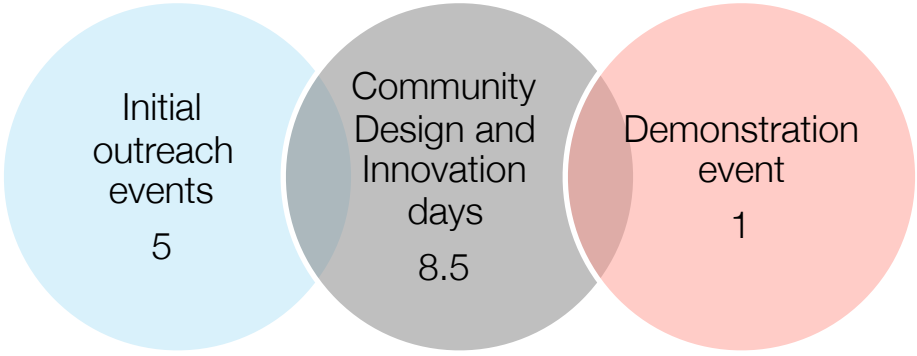


Figure 1: Number of engagement events carried out throughout the project

Sea Synergy Net Reuse (SSNR) - Design

Through delivery at outreach events, design days and developing an online presence via a website page and a facebook group the project interacted directly with over 470 individuals. A breakdown of this is shown in the graphic below.

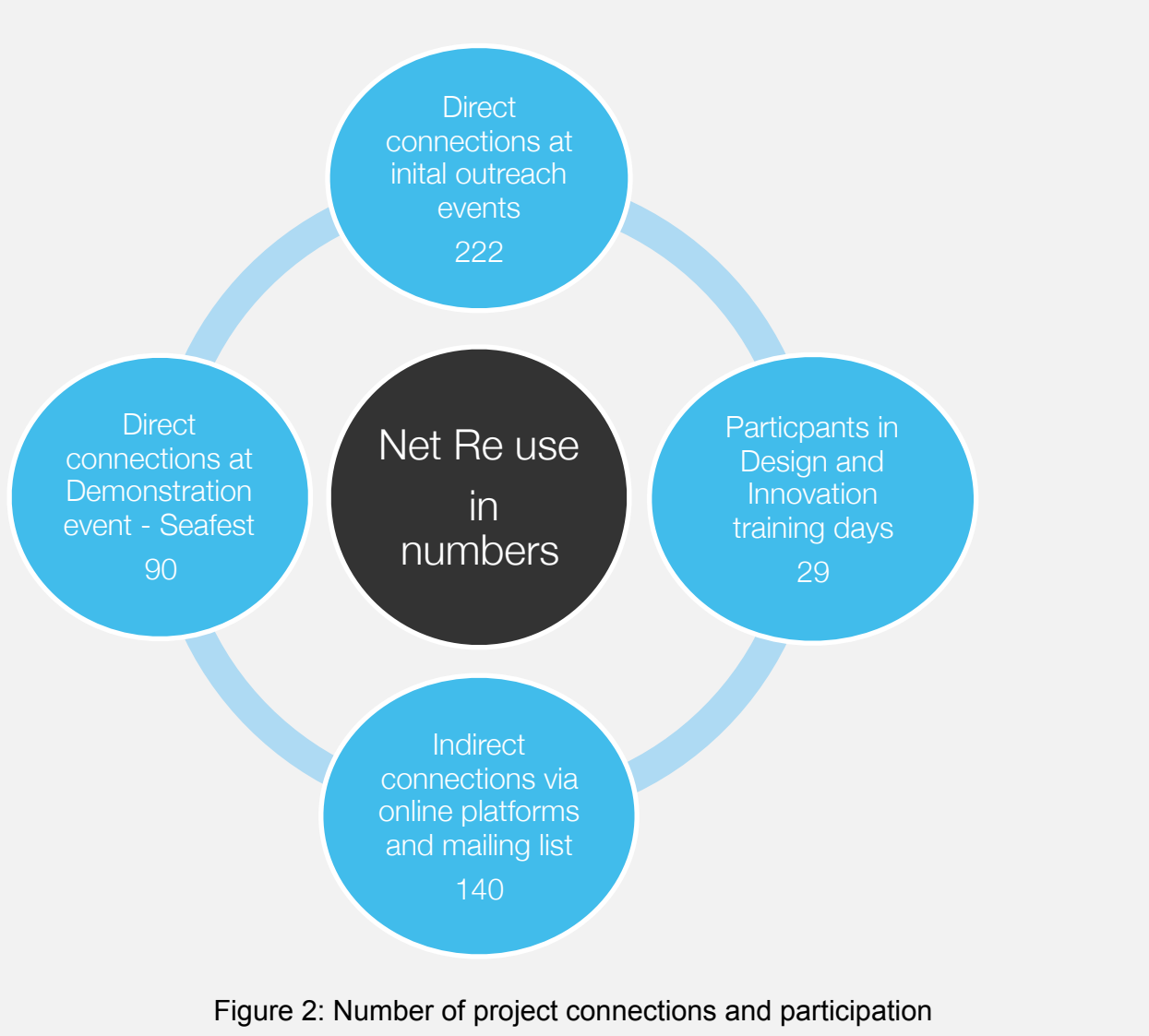


Figure 2: Number of project connections and participation

The delivery of training and innovation days resulted in several prototypes ranging from simple artisanal craft e.g. pen holders, to larger outdoor furniture e.g. hammocks and day beds. Use of nets in decorative lighting, 3D printing and were also explored. Testing of the filaments for 3D printing were in large successful with a focus on tools used within the fishing industry and some other simple objects. Successful prototypes of net making needles and knot making tools were made.

On investigation into the possibilities of local enterprise it became clear that the artisanal craft products offered a very low return for effort to create, with a better opportunity for locally scaled re-use of nets being present by a light industrial open source approach whereby individuals would have access to required technology to 3D print objects as needed and so reduce costs rather than increase income. The project team using this tender as leverage has secured additional EPA funding to pursue further the re use of net off-cut material using 3D printing within light industrial

1. Introduction - Sea Synergy Net Re-Use (SSNR)

Seafest, Cork 2019 image credit SSNR

Closing the loop - a circular economic approach to *'identify uses for pre-used fishing net material offcuts generated from net manufacturing'*

- *BIM Invitation to tender 2018* through research undertaken by Sea Synergy Net Re-use (SSNR) team

Sea Synergy Net Reuse (SSNR) - Design

“To find ideas, find problems. To find problems, talk to people.”

-Julie Zhuo




The BIM tender sought to consider of avenues for small localised options to re-use for net manufacturing off cuts through a circular economic approach as transport expenses and logistics were deemed prohibitive to large-scale centralised options. Diverting the material waste from landfill would reduce costs for net making companies and potentially create opportunities for coastal communities to generate additional revenue by utilising waste off cuts as a resource existed. The BIM tender outlined the following key aims and objectives to consider such opportunities;

Objectives:

- Develop additional revenue streams for the local fishing communities around the Irish coast through a local development group, sea scouts, man sheds or festival committees
- Raise awareness of waste prevention and reuse opportunity for fishing gear to fishing industry and the wider public

Outcomes:

- Development of a design concept and of four prototypes for replication in local community settings this could comprise from key rings to hanging baskets or hammocks etc.
- Provision of at least 4 days of community training courses to be delivered locally; training in the use of hot knives, glue guns and other appropriate art and craft equipment as well as marketing communication
- Delivery of 1 demonstration event to show the versatility of clean netting material and not as unusable litter
- Development of a showpiece to encourage discussion around marine litter and utilisation of unused netting as art material

Original tender to run: Feb 2018 - November 2018. NB: This was delayed as contract was not offered / signed until July 2018 given changes to budget.

1. The team's original tender proposed a consideration of the full spectrum of the problem of synthetic nets; virgin offcuts and used waste nets either retrieved or gathered from the beaches. This was accepted. In early Sept. 2018 BIM clarified post-contract completion that the team were to consider only virgin off-cuts [not found or used nets] in the process and to drop working with Clogherhead. The team had already completed some initial research, which is included in the report but clearly identified as beyond the scope of the revised tender and will be pursued through additional funding through the project MARplas - section 7.

2. Further changes occurred to delivery based on conversations with BIM project officer, Mo Mathies at a meeting in Dublin with design / engineer team regarding showcase piece. Discussion regarding showcase piece occurred with delivery as part of Sea Fest, 2019. Team heard no response until April 2019 and announcement of project officer was leaving. These delays have had some impact on the proposed project timeline and team's existing schedules and showpiece - see section 6.

2. The Problem landscape - an initial survey

How much waste is there?

In the last 20 years Irish Fishing net manufacturing has been replaced firstly with net production moving to Spain and Portugal and more recently India and China (Carrymacarry Net Works Ltd, 2019). The Irish fishing net industry now involves approximately ten net manufacturers all of which except, Carrymacarry Net Works Ltd, near Moville, Donegal are importing ready made sheets, which they then fashion into nets.

These nets are designed based on a number of factors; the size of the boat, the type of fishing / the catch and any specific requests that come from the tacit knowledge of the boat's captain. Due to the design of the nets the off-cuts are off a particular size - usually long and thin.

Many of the net makers e.g. KT Nets, Swan Net Gundry and Carrymacarry Net Works Ltd based in Donegal and GK Nets have diversified into sports nets and industrial netting enabling them to make use of some of the waste, other waste is taken by inshore fishermen for patching and mending their nets and pots. Also some of the net makers use the off-cuts to do repairs for fishermen; when a net can cost up to 180K it is not viable to get a new one nor is it in anyones interest to make it redundant while there is still use in it.

Through discussion with net-making companies - waste figures vary from maybe 2% - 10% but it is not clear what volume this actually represents and with the current global systems it is not considered financially viable to look at alternatives - however with the Single Use Plastic directive this may look different in the near future.

Further discussion with net companies, fishermen and Harbour Masters provided the following information;

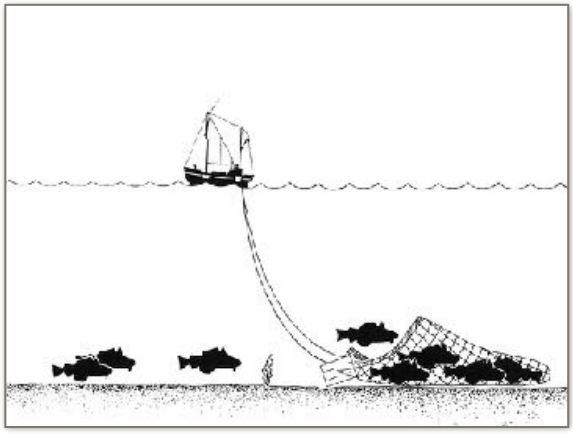
1. It can cost up to €195 to send a net to landfill depending on the size, weight and whether it has been stripped.

2. While there are some efforts to provide services to reprocess nets by private entities - the costs are high and it requires additional labour to strip the nets first from the peripherals by fisherman e.g. floats, ropes etc with no reduction to the service costs and no real gain to the fishermen giving the quantities or local authorities despite the cost per tonne in landfill - however this may change as waste regulation changes.

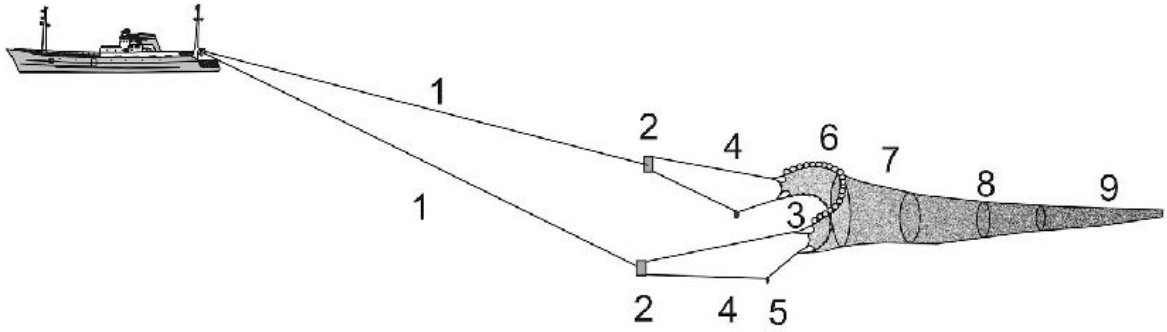
What sort of waste is it? - see also section 4

Currently fishing nets are made out of a range of synthetic materials which is somewhat dependent on their function - e.g. demersal, pelagic, inshore, gill net, longline. Pelagic fishing mostly uses nylon nets, while bottom trawling is mostly Polyethylene (PE) or Medium - High-density polyethylene (M or HDPE). The net waste is currently managed

by the Dept. Housing, Local Government and Planning, most of which is either placed in landfill or some reuse by local inshore fishermen, net makers to fix / mend nets or pots.



Bottom (Demersal) trawling - PE / PP / M / HDPE - Cod, Haddock and whiting



Pelagic (midwater) trawling - Nylon - Anchovies, shrimps, tuna and mackerel

The predominant catch of the 6 fishery Harbours in Ireland managed by Dept. Agriculture, Food and Marine is mostly white fish, which is undertaken by demersal or bottom trawling, which are mostly made from PE / M or HDPE nets.

- Killybegs - mostly pelagic - only 2 white fish boats in Killy begs
- Castletownbere - Ireland's largest white fish port
- Dingle - White fish 50:50 3rd biggest landed catch in Ireland
- Rossaveale - 50:50 white fish
- Dunmore East - White fish
- Howth - Prawn / Whitefish - inshore non-quota pots

Foreign landings at the fishery harbours for whitefish are mostly gill net or longline, which with pelagic nets are also nylon construction, which already has a value in recycling. There are also a number of Local Authority owned harbours including approx: forty secondary ports and a further eighty piers and landing places where fish landings are recorded. These would be mostly inshore fisherman and would including Prawns, Shrimp, Shellfish, Pots and Lines, with a mix of nylon and PE / M or HDPE.

The materials involved Nylon, Polypropylene (PP), Polyethylene terephthalate (PET) or Polyethylene (PE) / High-density polyethylene (HDPE) -

Nylon: First developed in the 1930s as an alternative to silk has lots of qualities that make it valuable - strong, quick drying, holds dye, less expensive than silk and is very robust. It is a thermoplastic polymer and becomes liquid at 220 degrees C and often used as a substitute for low strength metals. Like most thermoplastics it can be heated, liquefied and cooled and reheated with minimal degradation making it good for injection moulding 3D printing and recycling. There are technical challenges to recycling nylon but due to its qualities is has a high value in the recycling market and those with specialist equipment and expertise will compete for it. Companies like Speedo, Patagonia, Aquafil all recycle nylon but increasingly the issues around micro-plastics is causing a rethink around these practices. Nylon has the resin identification code "7".

Polypropylene (PP) – is a thermoplastic "addition polymer" made from the combination of propylene monomers with a melt point of 160-166 degrees Celsius. Current global demand generates approx. 45 million metric tons p.a. which is estimated to approx. 62 million metric tons by 2020. Mostly used in packaging it is also added to textiles due to its ability to copolymerise and often combined with polyethylene for this reason and sometimes used within netmaking with a resin identification code of "5".

Polyethylene (PE), / High-density polyethylene (HDPE) is known for its large strength-to-density ratio and is harder and can withstand higher temperatures (120 °C/ 248 °F) for short periods. Also a thermoplastic polymer, HDPE has a wide variety of applications e.g pipes, frames, membranes, furniture, bags, bottles, bio-medical, sheds, plastic timber, Coax and conduit and more. One third of global production (8 million tonnes) of hollow goods manufactured through blow molding are the most important application area for HDPE. Extrusion welding or wedge welded to form tanks gives increasing applications e.g. tanks and cell liners as it produces a homogenous barrier.
HDPE is commonly recycled, and has the resin identification code "2" which offers a useful opportunity for Ireland's net manufacturers as the predominant catch of the 6 fishery Harbours in Ireland managed by Dept. Agriculture, Food and Marine is mostly white fish which is undertaken by Demersal trawling, which are mostly PE / HDPE nets.

Polyethylene terephthalate (PET) is a thermoplastic polymer used predominantly for synthetic fibres (in excess of 60%), and bottle production accounting (30% of global demand) so most recycling is for polyester or PET pellets or flakes from bottles. Due to its low melt point PET can also be used for thermoforming and 3D printing processes. It degrades but this can be reduced by using a co-polymer and can be made into composites for strength e.g. glass fibre for engineering resins or within construction materials. This has opportunities for nets and ropes that may include PET.

A number of possibilities such as carpets or clothing has been developed so there are larger-scale opportunities that might become more viable as Single Use Plastic and Waste plastic management changes. Recycling is possible through several methods, chemical, mechanical and transforming to polls are all options. Chemical would only become viable on lines of more than 50,000 tonnes a year which would also have its own environmental impacts. Mechanical processes are common in small - medium size industry averaging 5000–20,000 tons/year. Sorting, separation and cleaning add

additional processes but are necessary due to impurities, PET / PETE packaging and bottles are commonly recycled, and resin identification code is “1"

What do we understand as the opportunities for this waste?

The original tender stated clean netting had proved popular for art and craft materials e.g. keyring or bracelets. However, it was hard to find significant evidence of this or specifics on the value of this, whether as materials or economic value in waste reduction. There as some anecdotal evidence from one of the net makers who supplies Re-create - see below.

SSNR’s Pinterest visual research board gathered details of artefacts produced from marine plastic waste but this was mostly rope or decorative nets rather than virgin fishing net off cuts / found net - see appendix 1 and further discussion in section 4.

BIM’s previous projects and research had identified the following opportunities;

- Ireland has 10 net manufacturers that produce waste and currently with three of these net makers - GK Nets, Pepe Trawls, Howth supplying materials for art and craft projects. This is undertaken through Recreate a social enterprise / registered charity that repurposes waste from a range of suppliers offering materials at affordable prices for creative activities to its members; schools, artists community groups.

- Figures cited are about 10% of total product but a lot of the total product is not fishing nets - as stated with net manufacturers diversifying this can include industrial netting, sports netting and ropes etc and the materials exact breakdown is unknown.

However, the amounts taken and the impact that some of this practice incurs may cause other problems, although small. For example, the polyethylene nets once cut or shredded, produce micro-fibres that are harder to manage ecologically and cause detrimental damage to the ocean and the food chain. Also, mixing with other craft materials glue, paint then minimise the options for end of life waste management - this is discussed further in section 6.

In Co. Cork, a net manufacturer Swan Net Gundry have supplying net off cuts to a Mamukko Ltd, a company producing sustainable and eco-conscious bags https://sng.ie/swan-net-gundry-uses-net-ends/

BIM’s Net Recycling Research - SSNR had already identified that upcycling PE / PP and Nylon as filament for 3D printing and pellets for injection moulding would be viable - see section 6. BIM has been facilitating the extraction of netting from the Irish and Spanish industry for more than seven years. Annually, an average of 50 tonnes of PA6 monofilament nylon is recycled. To date, approximately 320 tonnes of PA6 monofilament nylon and 14 tonnes of polyethylene (BIM Sustainability Atlas, 2017) have gone through the system.

In 2013, BIM had undertaken some pilot studies considering the commercial viability of recycled polyethylene (PE) with a Liverpool-based plastics recycler Centriforce Products following on from success with recycling nylon gear. BIM gear technologist, Myles

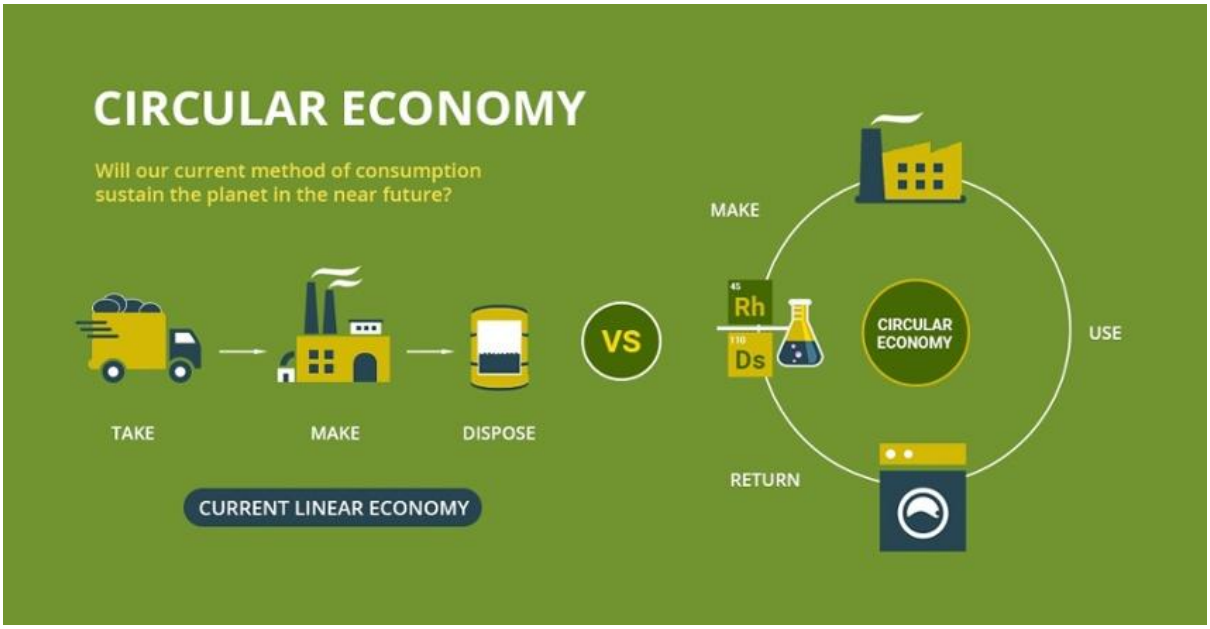
Sea Synergy Net Reuse (SSNR) - Design

Mulligan supplied MDPE pellets made from green fishing nets, which were made into sheets used as cladding of a water tank outside Electrolux. BIM are now also shredding nets and keen to roll out the initiative, which bodes well for further open source locally scaled initiatives.

https://www.google.ie/amp/s/amp.irishexaminer.com/breakingnews/ireland/government-hopes-to-extend-clean-oceans-initiative-across-country-897011.html

3. Circular Economy and the SS Net Reuse approach

The BIM tender identified that with the increasing emphasis on circular economy in all aspects of development, there was an opportunity to divert virgin waste from the net manufacturing industry that could create opportunities for additional revenue streams for coastal communities.



SSNR's approach to the circular economy does not only apply to materials but also the knowledge held within local communities encouraging a multi-stakeholder approach. SSNR proposed rather than creating 4 prototypes and training communities to make them, they would create workshops that would lead participants through and awareness and design process that would encourage ideas and solutions to emerge from the inside-out as opposed to a 'top-down' approach.

The approach includes design thinking and cradle to cradle considerations that would encourage and integrate circular economy concepts promoted by the European Commission in a tangible way. Inclusion of a co-design approach extends the concept of a circular economy by integrating aspects from a larger system; the latent potential of the communities to contribute to the process.

Sea Synergy Net Reuse (SSNR) - Design

Localised options are important not only for success of concepts but to reduce additional transport resources. As part of SSNRs approach to the circular economy we are also looking at opportunities for virgin net material and end-of-life netting that does not entail costly cleaning for up cycling / re use from within the fishing industry albeit in smaller quantities. Integrating this into the project is also something that we have been looking at within the project as this was part of our original proposal - see section 5

The design team has a mixed background including 3D printing, engineering, public art / design, textiles, ceramics, composite materials and construction processes. This was factored into the approach proposed and taken in designing the workshops offering avenues for group and individual exploration. An initial approach was to consider the nets as constructed textiles as it was felt that minimising the processing would limit additional resource use, build on locally available skills and work with the existing design of the nets.

Within a circular economic design approach keeping the net offcuts as close to the original sources as possible will cut down on hidden threats that may occur through processing of the raw materials and using utilities. Also, recycling processes can also mean degrading of materials and additional use of resources would impede aspects of a cradle-to-cradle / closing the loop approach. A life cycle analysis of additional processes could reveal other aspects that negate the potentially positive outcomes e.g. high use of water and electric or production of toxic emissions or substrates.

Further, craft or DIY scaled production makes it more feasible initially with local community's existing resources. Processes common within textile construction offer useful avenues for consideration, generally these are variations of interlacing e.g. weaving, knotting, crocheting, knitting, braiding and plaiting. These processes can require nothing other than a flexible material as the mode of interlacing is what forms their strength and form, indeed fishing net repair including patching and joining offers a solid foundation for DIY craft opportunities, with potential to utilise the fishermen / net makers' existing manufacturing skills - See section 6

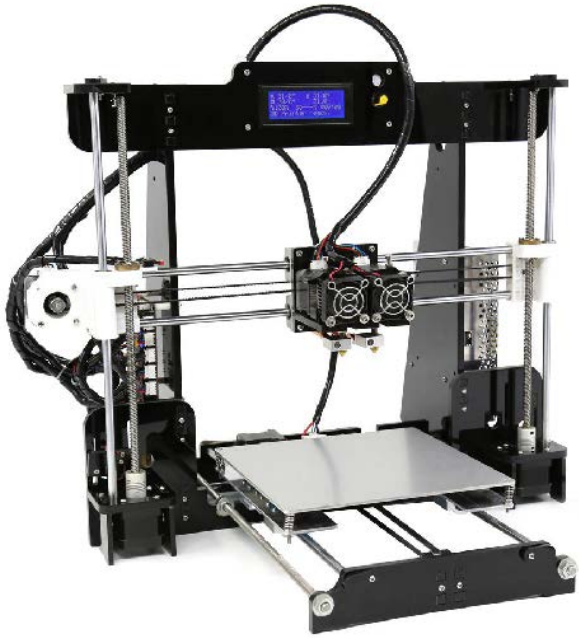
Open Source Light Industrial approaches - SSNRs original proposal also included Ghost Gear approaches and despite being accepted as such, this was revised after contract signing based on a misunderstanding regarding the language used in the BIM tender which stated pre-used rather than pre-use.

Our original proposal was informed by the expertise of the team, which includes 3D printing and the integration of art, craft and technology. 3D printing is recognised within contemporary art and craft practices and therefore fits within the objectives of the BIM brief - to produce artisanal / craft products. Although this would be suitable for virgin off-cuts, once pelletised or flaked then injection moulding or extrusion for printing filament in theory could be adapted for ghost gear. Although included in our original tender proposal, the up-cycling of used nets beyond our extrusion experiments will now be further investigated under confirmed EPA funding within three additional Flag regions; Donegal, Galway and Cork - see section 7

3D Printing Activities - Initial 3D printing testing was undertaken under 2 headings;

- 3D Printing of Processed Nylon Net and
- Filament Extrusion Testing of Pelleted Waste, in order to investigate the viability of 3D printing for marine waste materials.

3D Printing of Processed Nylon Net - The processed filament (discussed above) was tested on a consumer 3d printer (Anet A8), to test for consistency, usability and suitability.



These low cost (Sub €200) printers are common in fabrication spaces, maker spaces and libraries around Ireland, are easy to use. A number of test parts were printed, with particular focus for applications in the fishing industry to highlight the potential for the 3d printing of waste fishing material for the creation of useful additional parts. This fully circular approach (using fishing waste to produce useful fishing tools) is a key goal of this project.

These parts will also be used to help connect the concept of the project, the materials and the outcomes, in the minds of fishing communities. These included:

1. Net Needles (PLA & FF Nylon)
2. Knot Removal Tools (FF Nylon)
3. Basic Hook (PLA)
4. Fishing Lure (PLA)
5. Bag Handles (PLA & FF Nylon)
6. Skipping Rope Handle (PLA & FF Nylon)
7. Box Labels (FF Nylon)
8. Fly Lure Box (PLA & FF Nylon)

Initial testing was very positive, with the recycled material running reliably through the 3d printer. There was sort warping and curling of the nylon parts, due to thermal contraction during printing, but this can be tackled with the use of a glass heated bed. The nylon material itself gave high strength parts (some flexing when initially removed due to heat retention), particularly suited to the marine environment.

There were some inconsistencies between Nylon spools, possibly due to material or processing changes, meaning each spool needed to use a separate specific

temperature to print at highest quality. This is to be expected of such a new product, and should be removed as processing improves. Printing with this material will continue, testing various part ideas and concepts, on numerous printers to continue testing the printability of the materials, and parts to be printed.

Nylon's properties e.g. Relatively high melt temperature, composites well with other materials and low-friction, make it a versatile choice particularly for parts that see a lot of wear and tear. We know there are now commercially available filaments for 3D printing and the process of pelletising for this can open up avenues for injection molding - in which case anything currently made of plastic depending on legislative limitations e.g. food / medical grade requirements could theoretically be made using old and virgin fishing nets.

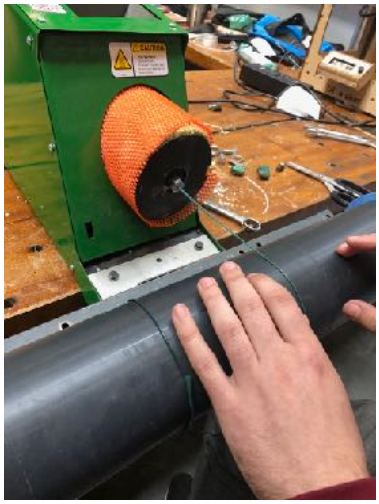
Filament Extrusion Testing of Pelleted Waste - The second phase of testing was the filament extrusion of pelleted waste plastic, a sample of which was received via SOURCE. 3D Printers utilize a 1.75 or 3mm diameter plastic filament, which can also be produced using a filament extruder. Initial tests were conducted on a Filabot EX2 filament extruder. These tests used an unknown polymer type, in pellet form. These pellets were fed into the Filabot extruder, to produce a 1.75mm filament sample.

3D plastic filament

Filabot open-source extruder

The unidentified polymer pellets were very inconsistent during extrusion, varying in flow rate, composition and therefore quality. This suggests the material is a composite of multiple polymer types. Communication to the manufacturer will help shed light on the composition of the polymer, thus helping to improve the quality of the extruded filament. Further filament testing will be undertaken, utilising another lower cost filament extruder (Filabot) and further material composition information will help in refining the extrusion process. This refinement will be used to increase the quality of the produced filament, which will then be tested in the 3D printer itself.

Within a circular economic approach developing prototypes that utilise this resource is important, particularly based on BIM's processing figures. This was also off interest to the fisherman and young people we spoke to as well as some of the development companies / associations we are in touch with regarding the next stage of the project. This would offer opportunities for printing some aspects that are used frequently but also develop new skills and offer different opportunities.



Extrusion experiments with MDPE pellets from used nets

One of the team is a fisherman by trade and in considering a circular economic approach we went through a 'day in the life' - a step by step plastic breakdown of the different jobs that utilise plastic within fishing. This became the starting point for some of the items we printed from nylon net filament as a proof of concept and will be looking to develop this further once SSNR is completed - see section 7.

Out of a list of possible products within BIM we explored printing fishing net needles and fish box labels form nylon nets as these are not currently recyclable. We would need to make them bigger and find a way to add an address to the labels but we received good feedback on these including considering them as luggage tags. - see section 6 and 7

4. Market Research

The Sea synergy team have established connections with a number of organisations through their professional engagement with the issues caused by marine plastic waste that informs their approach to the proposal e.g. Circular Economy, Portugal an education an innovation hub utilising a maker / fixer ethos, Mamukko, Kinsale designers who make bags using reclaimed marine textiles, liferafts and sails or which could align with other local proposals e.g. *Remade in Kerry*.

Circular Ocean's net re-use research (Charter et al, 2018) reviewed 19 cases of producers of market ready products re-using fishing nets. It should be noted that the majority of the products reviewed are non-essential or consumer items that could also be made or replaced by other products e.g. jewellery, sunglasses, games, and could through a full life-cycle analysis be perpetuating a problem. When considered inputs (energy, other materials e.g. non- recycled polymers, colouring agents etc) processes

(energy, water, waste) outputs (further end of life / waste issues) are increased through industrialised processes.

Of the 19 producers reviewed, most are micro-businesses or SMEs (16), located in the USA (6), USA / UK (1), USA / Chile (1), UK (4) and mainland Europe (5) Canada and Chile (1) all contributing to additional resource use through their exports and production outputs.

Visits to Swan Net Gundry, Union Hall and Killybegs highlighted the fact that core nets are produced in Europe, mainly Spain and Portugal, however increasingly this is being replaced by imports from India and China. Imported in bales, patterns are then cut to the design required at the local sites. The nets are standardised depending on specific catch and catch technique e.g. Demersal, Pelagic or Seine with the size of the inside mesh used as the defining measure e.g. 80mm, 90mm. These are commonly made from synthetic materials, as in multifilament nets, braided lines of polyethelene, a thermoplastic polymer resin or monofilament nylon.

Product Categories

An online review using Pinterest was created and shared with the various participants to gain insights into which they were attracted to and could imagine making.

Product review: https://www.pinterest.ie/CoDesRes/projects/bim-net-reuse/

SSNR promoted a process that started with the participants rather than teaching them to make prototypes the team had devised. This was to encourage buy-in and sustainability as well as bring knowledge into the problem that could be overlooked and therefore limit possibilities. We also developed a slide show from this that we used to present to groups in advance of workshops or at the beginning of a session - see appendix

Sea Synergy Net Reuse (SSNR) - Design

Category	Product / Materials	Design / Making level
Furniture: Indoor and Outdoor **Range of Markets / Outlets** Home / Garden Garden centres Public Gardens Museums / Cafes Schools and Playgrounds Also online store and local outlets - e.g. garden centres etc	Seating using tyres and 'threading' net / rope across central hole. Can also use net mesh as base for weaving other materials through Can also use glue to stick wound rope on to cover tyre Hammock style / deck and suspended chairs and shelving - variations using old pipes / wood as frames can integrate plastic rope also and weaving techniques - see above re: chair Babies suspended chairs / Cribs	Can be made easily and added to with arms / backs depending on skill level. Colours of nets / mesh can be used as part of design Could also use various techniques to create 'range' As above range of styles and designs depending on skill
Decor	Lampshades / Light covers Plant pot holders / coasters Storage baskets Suspended storage Mats	Utilises mesh to create shadows Utilise coiling techniques Utilise basket weaving techniques with old rope / net off cuts Using weaving techniqes and knotting to use plastic ropes

Fashion / Accessories	Bags Espadrilles - using plastic rope	
Leisure	Beach shade tent - mixed materials , Former, net and weaving materials to in-fill	
Play	Sensory packs	Small cut sections and specially designed activity sheets - bagged
Sculpture	Social sculpture - includes function that draws attention to the issue. Modular pieces - that form a bigger piece - these could be produced by 3D printing or injection moulding through social enterprise outlets	Depends on project - can be small or large scale. Larger scale brings in H & S. Planning permission and installation issues as well as funding

Existing products - Light / Semi Industrial

Company	Product	Comments
BPI recycling, Cardiff	Industrial / Agri film production	LCA to consider if polynet / rope can be used within this process, integrating Blue / Green Economy opportunities
Parcabout Ill De Groix, Brittany https://www.parcaboutgroix.com/	Highline leisure park	Adventure activities made by fishermen on the l'Ile de Groix – this could offer 'bad weather day' work opportunities to the local fishing communities. Locally, the 'rope' walk in Kells has already proved popular and sets a precedent when considering the market.

Blew-Stoub, Brittany	Rigging	World class market leader specialising in the manufacture of attachments, rigging, textile standing rigging and the supply of high performance rope.
Healthy Seas, Portugal	Socks / swimwear	Re-use of ghost nets for clothing - how does this impact re: micro-fibres
Econyl, Italy	Clothing	Econyl is nylon waste remade into yarn potential of micro-plastic entering the system through clothes washing. Main production processes are in Lublijana / Slovakia
Bureo, Chile	Recycled fishnet, skateboards	Based in Chile - export has environmental implications as does products e.g. micro-plastic entering the system through clothes washing
Fishy Filaments, Cornwall	Nylon filament for 3D printing	Developed and tested e.g. tensile strength etc but seems inconsistent in batch testing
Macroom Enterprise, Cork	Construction	Composite materials - re-enforced construction
Ocean Energy / NUI Galway	Fibre-reinforced polymer	Marine Institute award - develop composite material for harsh conditions for Marine Energy and Aquaculture

Another aspect we explored was recreational angling; sea and river. A high proportion of recreational fishing related jobs are located in the most peripheral and rural parts of the Irish countryside and along our coastline. Further, fishermen particularly retired fishermen make additional income as charter boats for sea fishing tourism. Recreational angling can attract domestic and international tourists which provides significant additional direct and indirect economic benefits to rural regions. Statistics from the 'The Economic Contribution of Bass and Sea Angling in Ireland (National Strategy for Angling Development document, 2015) showed

- total direct expenditure of anglers from all markets (Ireland, Northern Ireland and overseas visitors) on Irish bass and sea angling is in the region of €52 million and €116 million respectively.
- total direct expenditure on recreational bass and sea angling in Ireland by anglers from all markets is estimated to be of the order of €168.6 million.

Further, recreational angling also has the ability to attract anglers at times outside of the main tourist seasons; the shoulder periods of March through May and again from mid-August through to October, The extension of the tourist season provides increased employment through the tourism service providers also.

Despite some decline, the 2017 Waterville Angler survey, showed there was potential for development within the angling tourism. Focused on Waterville / Ballinskelligs bay on the Iveragh peninsula is known for its trout, salmon and bass fishing, the survey showed that Anglers stayed longer and spent more money during their holidays.

Bass anglers are keen to conserve the breed and are happy to adhere to the EU catch and release regulations helping to develop a sustainable opportunity. We begin looking at, lures and fly fishing equipment and were able to print floats, knot making tools for flys and fly holding boxes. More research showed a number of other options; spinners, spoons, swimbaits, tubes and worm imitators would all be possible but we did not pursue those options.

We also began looking at the materials and processes e.g. ropes that were also part of the ecology from the net makers when we were sent samples. Our solution to this was skipping ropes - a simple form printed from nylon nets using rope samples which could be spliced to make long colourful ropes or ropes that are stripped from nets before further processing. - See section 6

5. SSNR - Co-Design Processes

Please refer to mid-term report Jan 2019 for details of outreach and engagement.

The co-design process proposed was undertaken in three distinct formats all providing templates for future training - Innovation Days, Problem to Pitch Intensive and workshop sessions. **Total 50 hrs - approx 6 hr working per day (breaks not incl) = 8.5 days.**

- Innovation Days - Portmagee / Waterville - 10 hrs
- Problem to Pitch - 5 x 6.5hrs - 32.5 hrs
- Irish Country Women's Association - x2 3 hr sessions 6 hrs
- Men Shed - did presentation and visit but no uptake 1.5 hrs

Our initial premise as presented in section 3 was to minimise the processing, resources and maintain the integrity of the nets as much as possible. We began with the consideration of textile construction, which has four main material sources, animal (wool, silk), plant (cotton, flax, jute), mineral (asbestos, glass fibre), and synthetic (nylon, polyester, acrylic) and distinct processes; (dying, splicing weaving, knotting, knitting, crochet, spinning, binding and de and reconstruction using a mix of methods.

Innovation days 1 and 2: Constructed textiles experiments

Crochet

Weaving

Splicing

Exploring minimal processing; Nets are constructed textiles and our first innovation day explored some of these ideas

Coiling, wrapping and knotting

Innovation days 1 and 2: Constructed textiles experiments

Exploring minimal processing; Nets are constructed textiles and our first innovation day explored some of these ideas

Closed Loop - Bike lane separators - https://closedloop.com.au/bike-lane-separators/

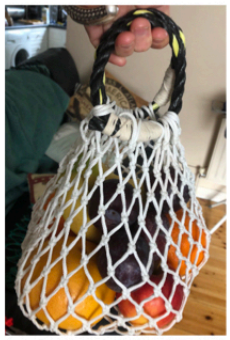
Textiles also readily lend themselves to the creation of composites (inclusion with other sustainable materials to explore ideas of packaging, fabrics) e.g. inclusion of plastic cups with recycled nylon for strength - e.g. closed loop bicycle lane separators https://vimeo.com/323624579

Innovation Day 1, 6 hrs template

Innovation days 1 and 2: Constructed textiles experiments





Introduction - 30 mins:

- Outline of the day
    - Warm welcome / putting people at ease
    - Aims / cafe etiquette
    - Activities
    - Running order including breaks etc
- Project Intro:
    - AV Presentation
    - Team
- Organise groups based on numbers - min 2 / max 4 per table + facilitator / recorder

Part 1: Understanding the problem - World Cafe Observation I hr

4 Questions x 10 mins per group / question to discuss (10 mins per question) then 5 mins feedback / discussion of key points and any insights to whole group.

1. What is your connection to the problem of fishing net / marine plastic waste e.g. personal, professional, financial, environmental
2. How does the problem of fishing net / marine plastic waste impact you personally?
3. What do you think is the root of the problem of fishing net / marine plastic waste?
4. How would you fix the problem of fishing net / marine plastic waste?

Part 2: Who's involved / needs to be? - Boundaries / Resources - Zoning map x 45mins

- Each group with a facilitator do a Zone map - post its and base map - 15 mins
- Each group to add post-its to main map - don't double up on what's already there - 15 mins
- Brief discussion of results / insights

Tea/ coffee break - 15 mins

Part 3 - Distruptive Innovation - Worst idea ever - Colin to lead - 40 mins

Depending on the abilities / needs of the group the next section could be adapted with more structures / facilitated activities rather than self-directed.

Part 4a - What's out there 30 mins - self directed approach

- Intro to pinterest boards / existing projects
- Small Group Discussions
    - What did people used to do with nets
      What ideas resonate
    - Any ideas that are missing / new ideas emerging
- Whole group feedback / insights

Lunch - 30 - 45 mins - depends on time

Part 4a Making exploration of ideas - 2 hrs - self directed approach

Part 4b structured variation group Audit: 40 mins depending on numbers - this is facilitated team-building / creation

- SWOT - each person to do SWOT / E. Box - (this should where poss. Include personality traits / values, motivations etc)
- Whole group skills - Skills / experience / interests - 10 mins

- Includes filling in whole group chart - use post - its to show

- Organise innovation teams - (3 or 4 per team but depends on numbers)

- Facilitate team Roles / Responsibilities (Proj. Mgmt, Designers, Subject expert, Stakeholders)

Part 4C Design thinking / pCr review of information gathered from the WC session - 10 mins

Part 4D Exploratory making / Prototyping session - 1 hr 45 mins - as a team prototype 2 ideas from group innovation sessions - tea break in between idea 1 and 2

- Using nets, glue guns, knives scissors, sticks, paper plasticene etc to prototype / explore ideas
- Idea 1 - 45 mins
- Idea 2 - 45 mins

End of day 15 mins review - who wants to pursue ideas further

See section 5 for prototype outcomes

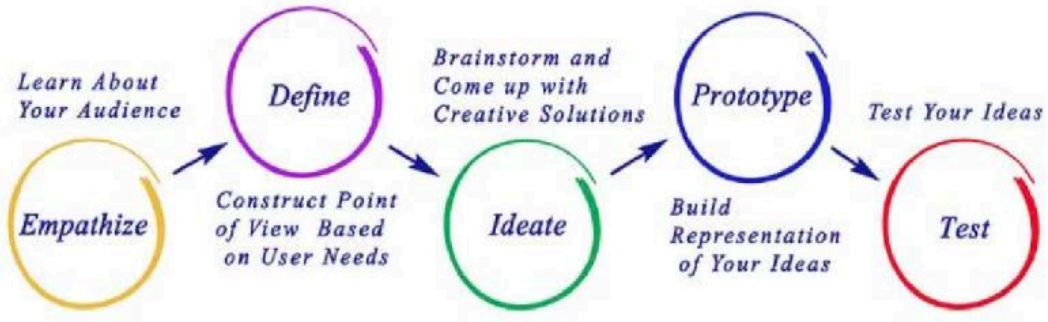
Sea Synergy Net Reuse (SSNR) - Design

Problem to Pitch template:

The week introduces work placement students to interdisciplinary design research and includes a number of design methodologies for 'wicked' problems and ethical design solutions. All tasks are supported by the team throughout.

Methodology: Design thinking and pCr framework

Stages in the Design Thinking Process:



PermaCultural Resilience Framework / Tools:

Tools: OBREDIM, LCA and Zoning tool and if time Vital Signs matrix

Week Outline: x5 days 9.30am - 5.30pm incl. X2 15 min breaks and lunch 1 - 2pm
Sessions outline:

- 9.30 - 11.15 then 15 minute break
- 11.30 - 1pm
- 1 - 2pm Lunch
- 2 - 3.45 then 15 minute break
- 4 - 5.30pm

Materials / Equipment Checklist

- Projector, laptops, cables
- Wifi
- Flip chart paper for group graphics and one or more sheets on each table for participant drawing/notes/doodles
- Markers- thin or medium felt tip water based pens in a variety of colors for each group
- Roll of lining paper (for gathering and posting collective insights)
- Masking tape (sticks but easily comes off without tearing the paper)
- Variety of sizes of post-it notes (especially 3 x 5 or 4 x 6 unlined)

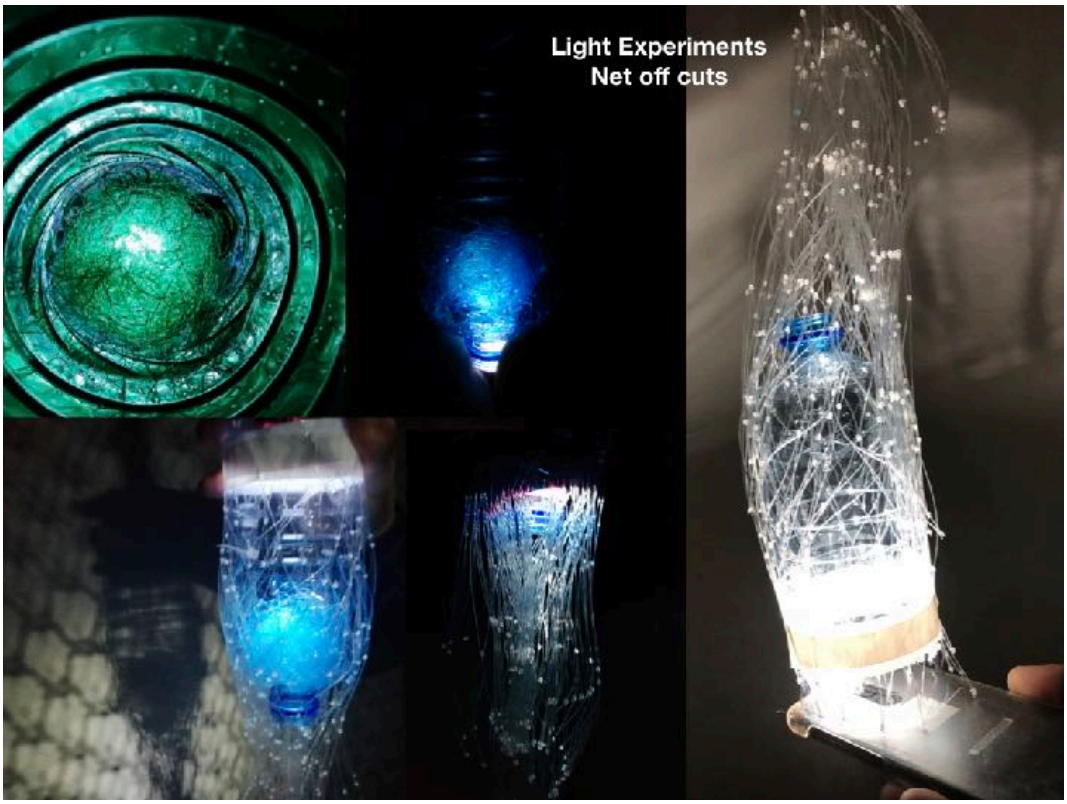
Sea Synergy Net Reuse (SSNR) - Design

Monday - Day 1 - Empathise and Define

- 9.30 am x 30 min Introduction: intro to week
- 10am Intro to the problem - PK Presentation and brief group discussion input from all present - begin to define
- 10.30 - 12.30 (break at 11.30ish) OBR worksheets - defining problem landscape
- 12.30 - 1pm 'What's out there' pinterest review, R & D quest / analysis
- 2 - 3.45 pm OBR worksheets - continue defining problem landscape
- 4 - 5.30 pm 'Worst idea ever' activity (Colin)

Tuesday - Day 2 - Ideate

- 9.30 am 30 mins quick fire share each group of previous day - see summary sheets
- 10am - 11 15 - Bio-mimicry intro - use worksheets (Anita) - R & D quest / analysis
- 11.30 - 1pm Cradle to Cradle / Circular Economy intro (All) and start task using OBR Zoning and life cycle analysis (inputs processes and outputs - worksheets)
- 2 - 4pm pm Continue Cradle to Cradle / Circular Economy task using OBR
- 4.30 - 5.30 pm - Introduction to Pecha Kucha pitch task for end of the week - incl LEAN canvas and task management



Light experiments monofilament net, PE green net, plastic bottle - D.Foxall, 2019

Sea Synergy Net Reuse (SSNR) - Design

Wednesday - Day 3 Evaluate

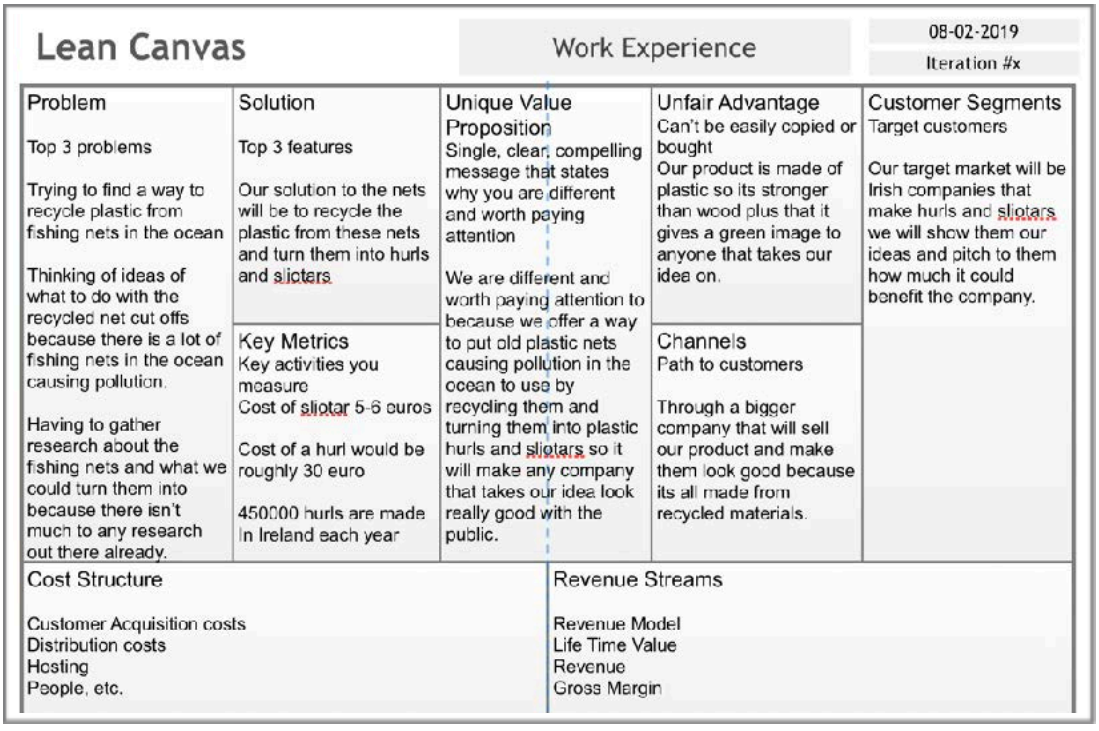
- 9.30-11am Visit to Iveragh Fisherman's Co-op
- 11 15 quick fire share review of Tues / Visit
- 11.30 - 12 use feedback and group analysis to select ideas for all team members to work on in small groups - teams / students mix
- 12 - 1pm The Remix incl Biomimetic remix - Anita to introduce the remix 'game' each group work on 3 - 4 versions for paper designs / ideas /
- 2 - 3.45 pm continue The Remix - x4 on paper designs / ideas
- 4 - 5pm - Group Problem-Solving / feedback on designs
- 5 - 5.30 pm - groups to document the day in prep for pitch - Q/A for pitch

Thursday - Day 4 Prototype - work on prototype and develop pitch

- 9.30 am 30 mins quick fire share - each group presents selected designs to prototype and completes lean canvas
- 10am - 5pm - spend the day prototyping breaks as standard
- 5 - 5.30 pm document the day for pitch and Q/A for pitch

Friday - Day 5 Test - test idea with Team through presentation

- 9.30 am 30 mins Review of Pitch task
- 10 - 3.45 pm Dragon's Den Pitch prep, breaks as standard
- 4 - 5 pm Dragon's Den Pitch x15 mins per group including feedback
- Week round up



Sea Synergy Net Reuse (SSNR) - Design

Short Workshops template: 2 or 3hr standalone session

Includes awareness raising and prototyping

Workshop image - March 19 and Guild Stand including SSNR teams Christmas Goods - May 2019

2hr session

- Introduce the problem and workshop - SSNR presentation - 15 mins
- Present Review of what people are producing - 10 mins
- Faciliated prototyping - 1 hr 30 min

3hr session

- As above with
- Problem landscape World cafe - 20 mins
- 2 hr 15mins

6. SSNR Prototype outcomes

The team developed a number of prototypes from within the team and within the community co-design sessions. All have the ability to be adapted and iterated based on individual or group making them.

- Seasonal products - Christmas
- Events materials
- Decorative Objects
- Bags
- Outdoor Furniture
- Sensory products
- 3D printing
  - Commercial / Recreational fishing
  - Skipping ropes
- Construction

Seasonal Products - As part of the initial outreach the team developed a number of artefacts that were easily made and offered a seasonal product and presented at the Christmas Fairs the team undertook. These proved very popular at the fairs' with visitors showing interest in buying the items and offered useful insights into pricing.

Braided Nylon fishing net with coal and onion bags - detailing

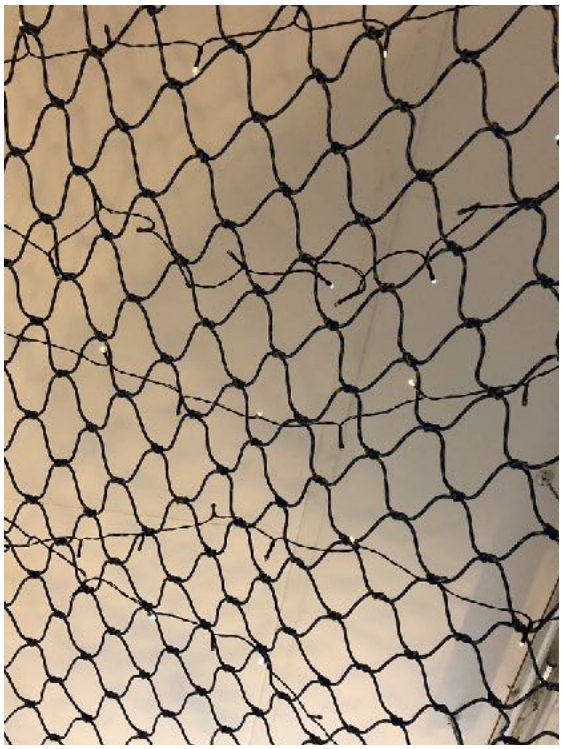
*1.**Silver coal bag as liner and onion bag bow***

*2.**Knots from braided net as inset***

Sea Synergy Net Reuse (SSNR) - Design

Sneem market - seasonal decor using rope ends from net makers

Events Materials - There are opportunities to use the nets given the length of off cuts within event displays and theatre. This was explored by the team and a local puppeteer. White nylon net was used as 'snow' and PE blue / yellow net used as 'night sky' threaded with solar lights within a recycled Santa's Grotto.



Net Sky and 'snow' - Santa's Grotto Cahersiveen

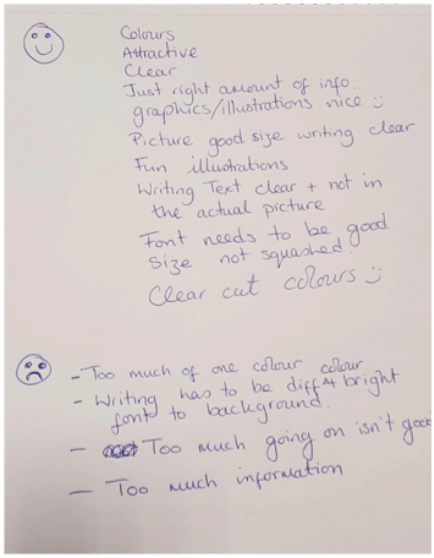
Sea Synergy Net Reuse (SSNR) - Design

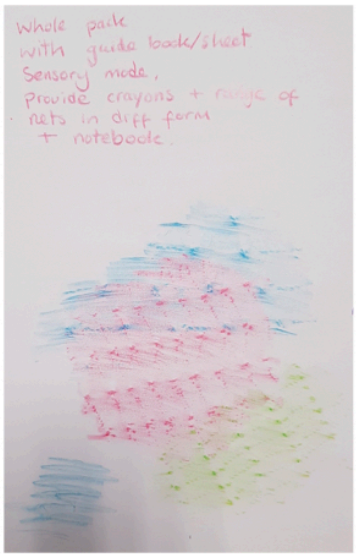
The puppeteer, Andrew Scattergood used a length of net with crepe paper and an air machine to form a set / backdrop for his The Mergle's Tale, a sensory story from deep beneath the sea of the not-quite mermaid girl Sheah.

Sensory Activities:- The sensory aspect is something that was explored during the 'Problem to Pitch' week, as an early learning or Special Educational (SEN) needs activity pack - using the nets colours, mesh and textures with activities that facilitate the development of emotional and sensory perception and motor skills would have value to pursue.

Several companies in the US e.g. Twinkl offer a range of packs and activities for SEN teachers, teaching assistant s or parents. The team briefly explored this and would develop this further to align with assessments of needs and produce a coherent appropriate series clearly defining the needs to be supported. With the correct packaging and marketing with strong educational support this could be a lucrative avenue to explore

Inclusive Design: - Members of the design team are affiliated to the Inclusive Design Research Centre and will be exploring this option further through the MARplas project.





Series of worksheets and activities in a complete pack

- Fidget toys to improve concentration and focus
- Visual explorations
- Tactile explorations
- Verbal Exploration

In addtion, we shared some net with a local music and sound installation artist who makes musical instruments and sound pieces using upcylced materials with the aim of developing community interaction. This can involve performance and education work.

Elaine, un-ravelled the fishing net to use for stringing hand and frame drums, which could be developed for market. The ‘stretch’ and strength of the net is a quality sought in drum making, necessary to achieve the tension on the ‘skin’, which in this instance was sail offcuts.This is something that will be explored further with Elaine as part of the MARplas project if this is something she wishes to pursue.

Hand and frame drums, drainage pipe, sail offcuts, inner tubes and fishing net offcuts, Copyright Elaine Bounce

Sea Synergy Net Reuse (SSNR) - Design

Companies such as Body and Soul, festival, Electric Picnic and theatre company Macnas would be a potential opportunity for the net waste whether as materials for construction and building for costume and performance or creation of suspended storage bags for other fabrics and materials. These could be adapted to any space and would utilise the skills of the fisherman by piecing together net lengths and rope edging as customised storage.

Suspended storage, loft nets and bed nets, Incord, 2019 www.incord.com

Bags - Net bags proved another popular item, easy to make and many of the workshop attendants had memories of net fruit and vegetable bags, the workshops yielded bags with a 'rustic' aesthetic based on the materials and initial aim to use minimal additional processes. However, we believe that there could be designed elements further integrated using 3D printing to create unique handles. We developed a simple functional 3D printing handle but more design work will be undertaken with groups through MARplas to explore and refine these ideas.

Sea Synergy Net Reuse (SSNR) - Design

Braided Nylon net with polypropylene rope handles - 4 grapefruits, 4 apples, 2 bananas and 2 pears 3D printed handles, a feature that could be designed easily and printed using nylon net filament to add value to look and feel

Problem to Pitch - beach clean bag reusing fishing industry container, bag for sports balls, Feb 2019

Decorative Artefacts - The innovation days and Irish Country Women's association yielded mostly decorative objects which are discussed in the conclusion. The participants utilised mostly rope ends which came from the net makers with some netting used on night light holders to create shadows. This is indicative of their choices and the approach to explore construction and scale - larger items were encouraged through different foci when applied to the workshops





Sea Synergy Net Reuse (SSNR) - Design

Constructed textiles - Coiling and stitching - during the innovation days we explored minimal processing using constructed textiles techniques. While the same products could be made quicker using glue guns, chemical adhesives add an environmental impact which impedes the 'end of life' re-use of any products. The techniques are adaptable to the maker with different stitches, threads and visibility of stitches all becoming design features if chosen.

Sea Synergy Net Reuse (SSNR) - Design

Outdoor Furniture - We shared our Pinterest board and presentation of what others where doing as a way to encourage the co-design process and give people a starting point - picking artefacts that resonated with them then supporting individual adaptation. Hammocks and seating were the most popular and aspects of these were explored using the least processing methods and a simple carbiner and knot suspension system.

These are methods easily adapted using existing skills and fittings from marine industries, e.g. knots and splicing. There are also hanging kits that can be purchased that could be factored into the price, these are available from €5 - €50 depending on whether its a full kit or modular fixtures and fittings e.g. ropes, springs, stands

Simple hammock construction.

Simple seat construction with Dowling

We also explored a simple wooden edged seat system but the time taken and need for additional materials begins to reduce the potential revenue / profit margins. The first exploration was simply using the construction of the nets and threading but the team feel a drilled decorative knotting system although adding time would add value and we will be exploring this further to see the impact of finishing on revenue generation.

Sea Synergy Net Reuse (SSNR) - Design

The hammocks and chairs could also be sold with free standing hammock stands which could be made or purchased separately from companies such as www.hammocology.ie Cork and factored into the costs. Connecting Hammockology.ie to net makers would be a useful avenue to pursue as they have stands and develop unique hammock solutions. Also the lengths of net available from the net making industries would need minimal processing

Opportunities to partner with hammockology.ie Cork seem viable and worth pursuing

Sea Synergy Net Reuse (SSNR) - Design

Seating:- Circular economic principals offer potential to utilise other materials with the nets that may come from related industries or activities the coastal or fishing communities also operate within e.g. food distribution, farming. Pallets can be repurposed to produce frames and legs and depending on paint, or finishing techniques can add value when marketed e.g. upcycled, distressed or vintage.

Out door day bed, pallet frame and legs - painted and up cycled

Agriculture and farming sits hand in hand within rural coastal communities, some fishermen work in both industries and would have access to waste materials that can be integrated into a circular economic approach to net waste - quad tyres offered stronger bases for exploring seating and can repainted or decorative attachment made as design features e.g.knotting, different coloured nets

Quad tyres, nets and knotting for outdoor seating

3D Printing - Utilising the nylon filament from nylon nets with the fishing related products both the circular economic attributes as well as potential 'awareness raising' or buy in value that would make a marketable product

Fishing net needles - printed in PLA and Nylon filament from nets

Fishing hooks, Knot making tools and fly / lure box printed in PLA and Nylon filament from nets

Fish box labels - During our demonstration events we had a lot of interest in these as luggage labels which could be customised.

Skipping ropes - Were another popular product at the demonstration events. Utilising the nylon filament from nylon nets with the lengths of rope that are often another source of waste from the net makers had both the circular economic attributes as well as potential 'awareness raising value that would make a marketable product.

7. SSNR - In Conclusion

The project highlighted a number of issues that we understood could be problematic but that were affirmed through the process. The outcomes of the project from the original document will be addressed individually;

- **Development of a design concept and of four prototypes for replication in local community settings this could comprise from key rings to hanging baskets or hammocks etc.**

Craft and Artisanal approaches:

This approach is limited even had the team developed the more conventional approach outlined in the original tender invitation the time taken to produce craft items even with free materials would be hard pushed to provide enough financial incentive to encourage take up by coastal communities, even if it was their idea and based on minimum wage.

For example - Standard Artisan pricing formula - An object that takes 1 hr to make

Time - €9.80 p.h. minimum wage over 20
Average wholesale markup x 2 -
Ave. retail Price x 2 -

Total retail price is = €9.80 x2 x2 = €39.20 wholesale price €18.60 less costs:

Utilities - €1.5 allowance per product (rent / electric etc)
Marketing - €1.5 - allowance per product e.g. Etsy platform / phone / Social Media marketing etc
Supplies - €1 free materials + small allowance for postage / other materials

Less €4 = €35 wholesale or €14.60 retail profit

This formula uses a very low hourly wage and basic markups, with a 2.2 rate being a more standard rate and using only approximate costs but it begins to show the economic reality of the issues around craft products. Even ignoring the wholesale and retail mark ups - thinking about what a customer might pay €13.80 for challenges what might be potentially viable products. Ignoring mark-ups etc to just get a basic minimum wage also then brings in issues of Fair Trade as undercutting other producers then lowers the value and removes the ability for crafts people to make a sustainable living.
Some of the products took much longer to make and it is unclear if there's a market for the products, while seasonal events e.g. Summer craft fairs, Christmas fairs are popular

in the region this will only offer small seasonal incomes and although helpful is limited. The awareness raising or feel-good products do have value. However, as we move forward and the issues around sustainability become increasingly clear the production of non-essential items may have a limited opportunity as despite their feel-good factors they can be considered as 'greenwashing' .

Also, although the prototypes developed were appreciated and indeed there was much interest showing in buying the products from us at the demonstration events. None of the participants, seemed motivated to develop their ideas. We will be undertaking additional research around the products as well as the creation of new products with the MARplas project in particular with existing artisans to see how this shifts as the motivation already exists to produce commercially viable products.

Open Source Light Industrial Approaches:

The products developed using 3D printing also showed potential and the fishermen we spoke to where interested in this approach as they could possibly save money (rather than earn) by replacing some of the plastic products they use e.g. labels. This would still increase their economic position. Within the phase 2, EPA funded MARplas project. We have begun to look at other plastic items used in fishing like spacers etc by creating composites by embedding steel cable as re-enforcing.

Due to BIM's exploration of recycling nets with Centriforce / Geoline - see section 2 the shredded pieces would have been smaller and more readily available to extrude. However, the pieces would need further processing to stop getting stuck in the extruder, which then has the potential to create micro-plastic fibres which are more difficult to manage, but with the right environment could be embedded in construction materials .

BIM PE net shredding and micro-fibres

Due to the low melt point we will be experimenting with baking them into sheets and

then grinding for extrusion and although this is two more processes given the open source DIY artisanal-scale this still causes savings. Joshua M. Pearce, Associate Professor for Materials Science and Engineering at Michigan Technological University, has been looking at distributed recycling / up-cycling since 2014 and has shown that this form of recycling can amount to between 3 % and 80 %, when the transport is also factored in (Pearce, 2014). This will also enable additional creative aspects for injection moulding and printing given the potential to mix and explore colour.

The cost of setting up a local maker space within Fishermen's co-ops, Community or Development Companies is achievable and would be a way to expand the potential of artisanal products produced within local communities as well as up-skilling for the 4th Industrial revolution (4IR) (Schwab, 2015) [1] .

The 4IR proposes blurring the boundaries of technologies; combining hardware, software, and biology emphasises advances in communication and connectivity. Breakthroughs in emerging technological fields such as robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology,the Internet of Things, the Industrial Internet of Things (IIoT), decentralized consensus, fifth-generation wireless technologies (5G), 3D printing and fully autonomous vehicles requiring different skill sets for the future of work. This and additional training could be supported easily through local development funding which we will be exploring through the MARplas project.

Local Maker 3D printing / extrusion set up (NET) €4930 - €7231 net

3D Printer Cost (Sub €200) x4	€600
Start-up Filament	€136

- Standard Filament Cost (sub €50) 1KG
- Up-cycled Fishing net Nylon filament 1KG €76

Full Filabot Extruder Set up €4400	€4400
Desktop Plastic Shredder (3DEVO)	€2295

Alternative Protocycler Integrated grinder and extruder (€1899)

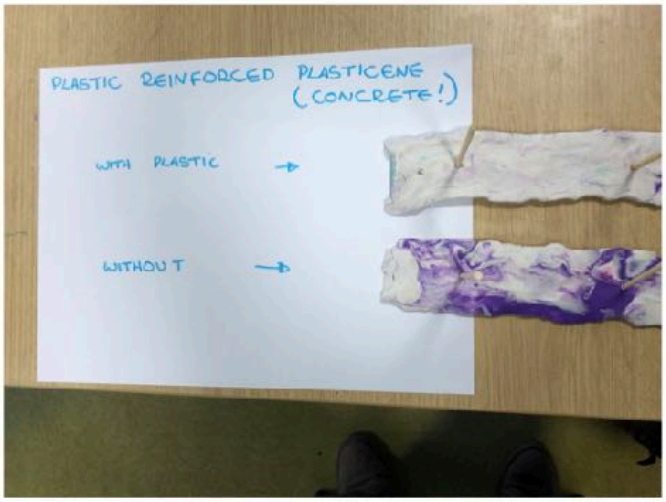
Other possibilities: - The team and co-deign participants initiated three other areas of experimentation construction (e.g. tiles, plastic wood, flood defences), vertical walls and decorative lighting and will be continuing this line of inquiry within the MARplas projects as they had not reached prototype level.

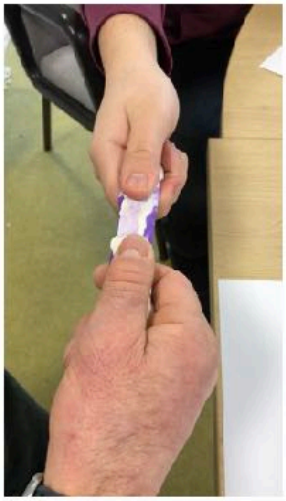
We will also be discussing this further within the MARplas project and hope to take the ideas to prototype level. This will include discussions with Macroom E as we do not

[1] Schwab, Klaus (2015-12-12). "The Fourth Industrial Revolution". Available at https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolutionRetrieved 2019-02-15

which to compete with existing avenues they maybe already exploring. We believe they are looking at composite building materials and re-enforcing
Also opportunities with Hammockology will also be discussed to see the potential for future partnerships or connecting net makers e.g. Swan Net Gundry, Union hall with them.

Problem to Pitch: Circular knowledge economies





- re-enforcing materials
- composite thunder / firework blankets for dogs
- sensory and therapeutic toys for children
- iPad mount / stands
- fence for animals instead of chicken wire
- baby / toddler gates.

Summary of Achievement on deliverables:-

Pictured at the Sea Synergy/BMI Net Reuse project in Tech Amergin, Waterville on Saturday were l-r: Anne Kennedy, Rebecca Le Marie, Lucy Hunt, Jill Coffey, Andrew Scattergood, Anita McKeown and Ger Deasy.

- **Provision of at least 4 days of community training courses to be delivered locally; training in the use of hot knives , glue guns and other appropriate art and craft equipment as well as marketing communication**

  Total 50 hrs - ave 6.5 hrs per day = 8.5 days.

  - Innovation Days - Portmagee / Waterville - 10 hrs
  - Problem to Pitch - 5 days - 32.5 hrs
  - Irish Country Women's Association - x2 3 hr sessions 6 hrs
  - Men Shed - did not materialise presentation and visit but no uptake

- **Delivery of 1 demonstration event to show the versatility of clean netting material and not as unusable litter**

  - Tales From the Sea; Old and New, Culture night 21st September 2018 - showed examples of products made from nets and undertook discussion around the issues of net waste management including raising awareness of

the complexity and addressing issues of 'blame'

Tales of the sea - SSNR Launch and talks from team and guests

- Seafest 7th - 9th June 2019 Exhibition stand and examples of prototypes, process and next stages.
- Heritage Week 24th / 25th August - springboard event bridging transition from SSNR to MARplas - showcasing BIM project prototypes with demos

In addition - the Cahersiveen Irish country women hosted a display of products they had made and presented the issues and information regarding the net waste issues to the Kerry County Guild of the Irish Country Women.

- **Development of a showpiece to encourage discussion around marine litter and utilisation of unused netting as art material**

  - Discussion with previous BIM project officer regarding this aspect of the project was in process with reference to inclusion as part of the Seafest festival. We met regarding this and were awaiting response on the design brief and how to proceed. We received communication that the project officer was leaving 1st April and that a new officer would be assigned, SS director followed up on this, 9th April and stated the position on this aspect of the project but we did not receive any further communication regarding this.

  - A few weeks before the event BIM informed us that we should independently apply to have a stand and showcase at Seafest. We did this and this was confirmed in mid-May which we used as our demonstration event. Demonstration pieces included some 3D printed objects as discussed above and several prototypes of artisanal products that emerged through the co-design process. These were well received with particular interest in the future

opportunities of 3d printing of recycled materials.

Further Research opportunities

New technologies and legislation are providing new markets for used plastics and increasingly companies that have the ability to recycle will increasingly compete against each other for the material.
This is good for the environment, as it keeps discarded nylon out of our landfills and waterways. And it's good for the economy, as the creation of post-consumer and post-industrial plastics creates jobs in and of itself; and the availability of recycled plastics has obvious economic benefits to builders, manufacturers, and their ultimate end-users.

Initiatives such as Fishing for Litter and the Green Deal Fishing for a Clean Sea are beginning to take hold in Ireland, Europe and beyond e.g. Philippines. There also seems to be some nascent initiatives with regards to re-purposing / cleaning used nets however research has shown these to be underperforming or not being promoted and there are options for a localised industry undertaking this process, which should be expanded.

Areas such as health and safety, bio-medical, sensing and ergonomic product designs are not fully explored. Further, there are currently no established inclusive co-design approaches to net reuse in Ireland and no scalable businesses models that reflect this approach or seek to support micro – large-scale opportunities that involve p2p, disruptive or collaborative systemic practices.

SeaSynergy's own research and professional connections have further identified products and initiatives that could be considered within a full lifecycle approach and be trialled and rolled out within their ongoing research, now funded by the EPA.

Develop marine plastic processing light enterprise project - Iveragh (Ballinskelligs Enterprise Zone), Donegal and Galway - all fall in under Udaras / Gaeltacht remit

Existing models like

- Digital Blacksmith - https://www.digitalblacksmiths.org/
- Ethical Filament - http://ethicalfilament.org/
- Plastic Bank - https://www.plasticbank.com/
- Precious - https://www.preciousplastic.com
- Protoprint, India - https://www.socialseva.org/protoprint/
- Rapid Foundation - https://www.facebook.com/TheRapidFoundation/
- Recyclebot, Michigan Tech Open Sustainablity lab -

Sea Synergy Net Reuse (SSNR) - Design

- TechforTrade http://www.techfortrade.org/

Have potential for localised approaches to marine and beyond plastic waste, with this in mind we will be undertaking a feasibility study to consider the following proposal;

Model: Iveragh ReUse (Ballinskelligs Enterprise Zone) roll out in other MARplas regions

Cahersiveen is also a Gaeltacht service town - so Udaras and upcoming enterprise funding would be possible

- **Option A: - Marine Plastic processing light enterprise model**
  - **MD - PhD Plastic Sequestration**
  - **Cill Rialaig artists partnership**
  - **COINLab support**
- **Option B: - Fishy filaments Nylon - sister company - PE / Ireland company**

The team have developed 9 ideas to be explored and will be addressing these within the MARplas project including a feasibility study.

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Appendix 1: Budget Update

Table showing Budget expenditure to date:

	Budget allocation	Budget Spend	*Discrepancies*
Project Management	1575	1575	*0*
Advisory	1225	1225	*0*
Engagement	5250	5250	*0*
Research	7525	7525	*0*
Delivery	4725	1925	*2800**
Training days	1050	960	*90*
Demo event	700	600	*0*
PPS	250	250	*0*
Website design and build	525	290	*235***
Website hosting	120		*120***
Materials	500	500	*0*
Travel	500	546.5	*-46.5*
TOTAL	23945	20646.5	*3198.5*

*Due to the discussed delivery on development of a showcase piece time allocations for the design team were retained to allow for construction of showcase piece as discussed. This has not been achieved to date, however as budget is available and if required by BIM can be completed post project.

** Underspend on website design and hosting – this occurred as the expected cost for development of a website was reduced by the addition of a dedicated page to Sea Synergy's existing website rather than new website development. This course was chosen as existing traffic to the established website ensured wider engagement with the project. Some time was also spent on developing a Facebook page as it was noted that many of the target audience i.e. small artisan crafts people, men's sheds etc. commonly use Facebook as a cost effective means of maintaining an online presence, thus continuing connections with these groups was facilitated through our own Facebook presence.