UK & Ireland Spill Association
THE VOICE OF THE SPILL INDUSTRY

Oil Spill Response

ORACLE Environmental Experts

ITOPF

University of Southampton

# THE NURDLE PROJECT

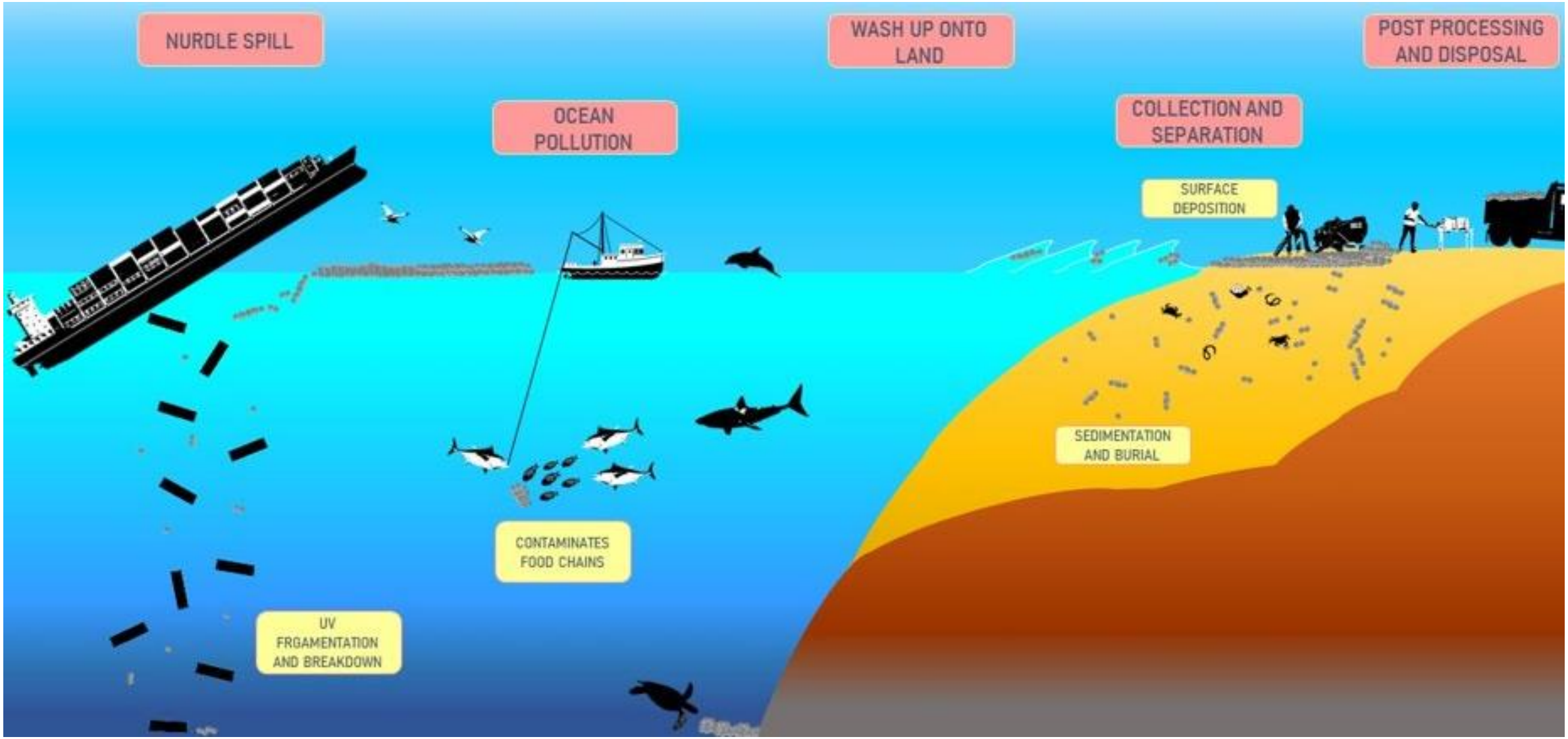
Develop novel clean-up equipment for the collection of nurdle pollution from sandy shorelines in response to nurdle spill incidents.


Team Members:
Sowmiya Aravinthan, Nirushaan Srithar , Amy Kerrison, Sajal Rana, Jack Searson, Eleanor Winterburn

Primary Supervisor: Dr James Blake
Co-Supervisor: Professor David White

# THE NURDLE PROJECT

1. Context and Research
2. Testing and Design
3. Field Testing: Shamrock Quay
4. Project Output


NURDLE SPILL
OCEAN POLLUTION
WASH UP ONTO LAND
COLLECTION AND SEPARATION
POST PROCESSING AND DISPOSAL
SURFACE DEPOSITION
SEDIMENTATION AND BURIAL
CONTAMINATES FOOD CHAINS
UV FRGAMENTATION AND BREAKDOWN

# 1. Context and Research : What is Being Done?

[16]

S. Durrance, 'Spills of Cargo Other Than Oil –Nurdles', ITOPF, Jan. 2022.

## Nurdle Collection

S. Durrance, 'Spills of Cargo Other Than Oil –Nurdles', ITOPF, Jan. 2022.

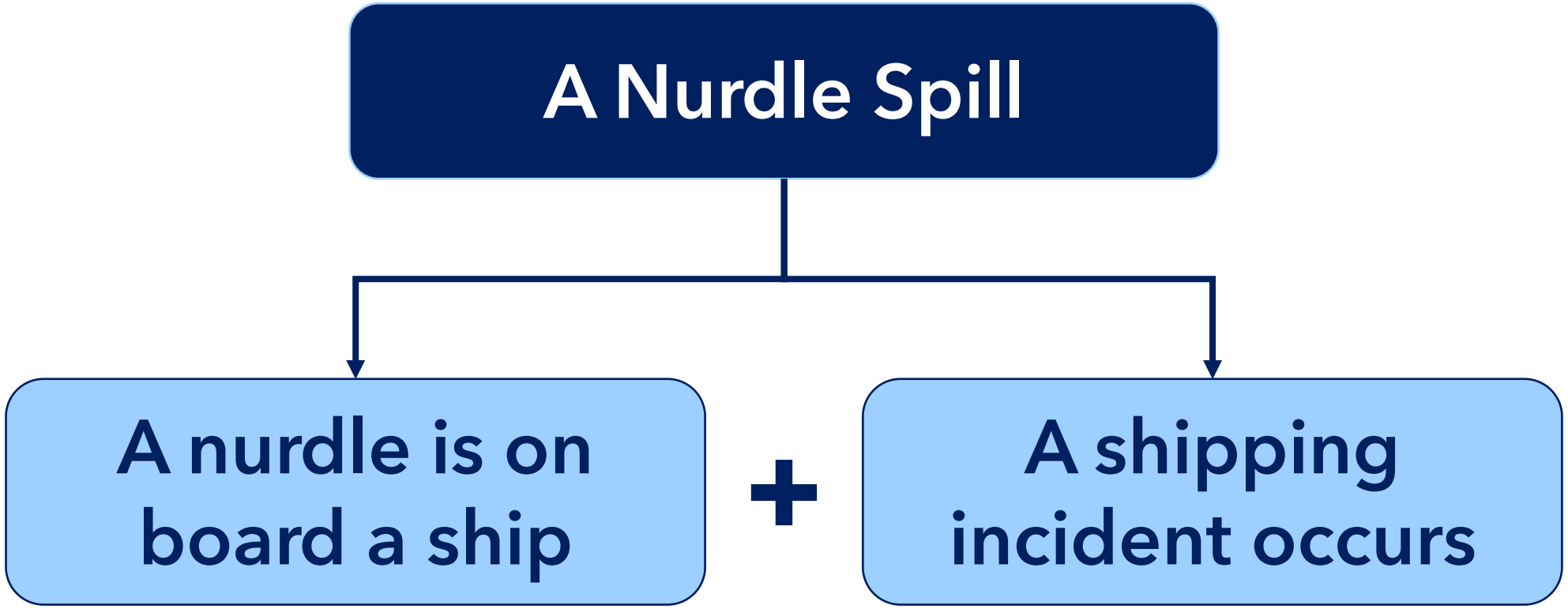
S. Durrance, 'Spills of Cargo Other Than Oil –Nurdles', ITOPF, Jan. 2022.

## Nurdle Separation

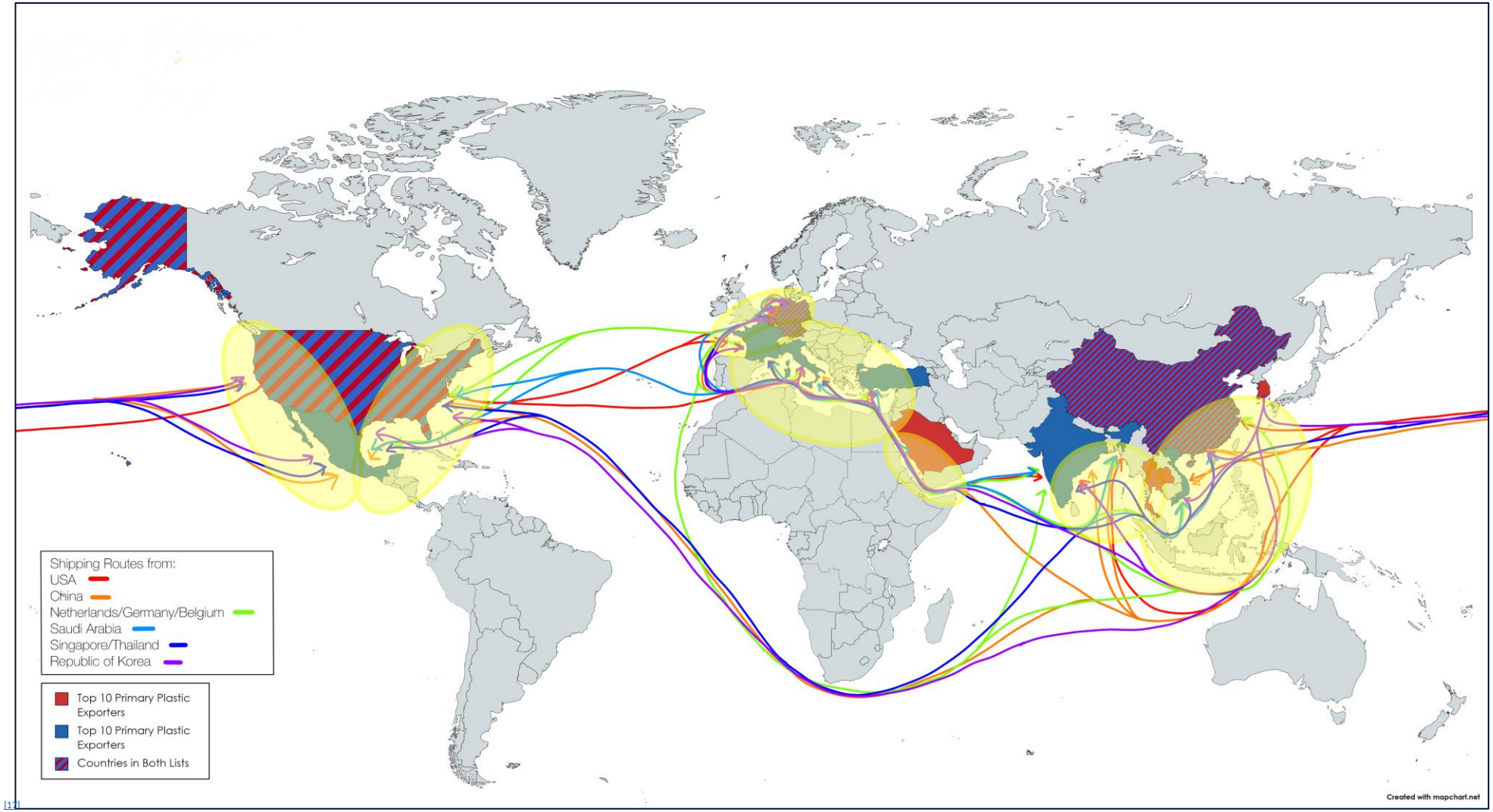
S. Durrance, 'Spills of Cargo Other Than Oil –Nurdles', ITOPF, Jan. 2022.

S. Durrance, 'Spills of Cargo Other Than Oil –Nurdles', ITOPF, Jan. 2022.

A game of probability, the Swiss cheese model….

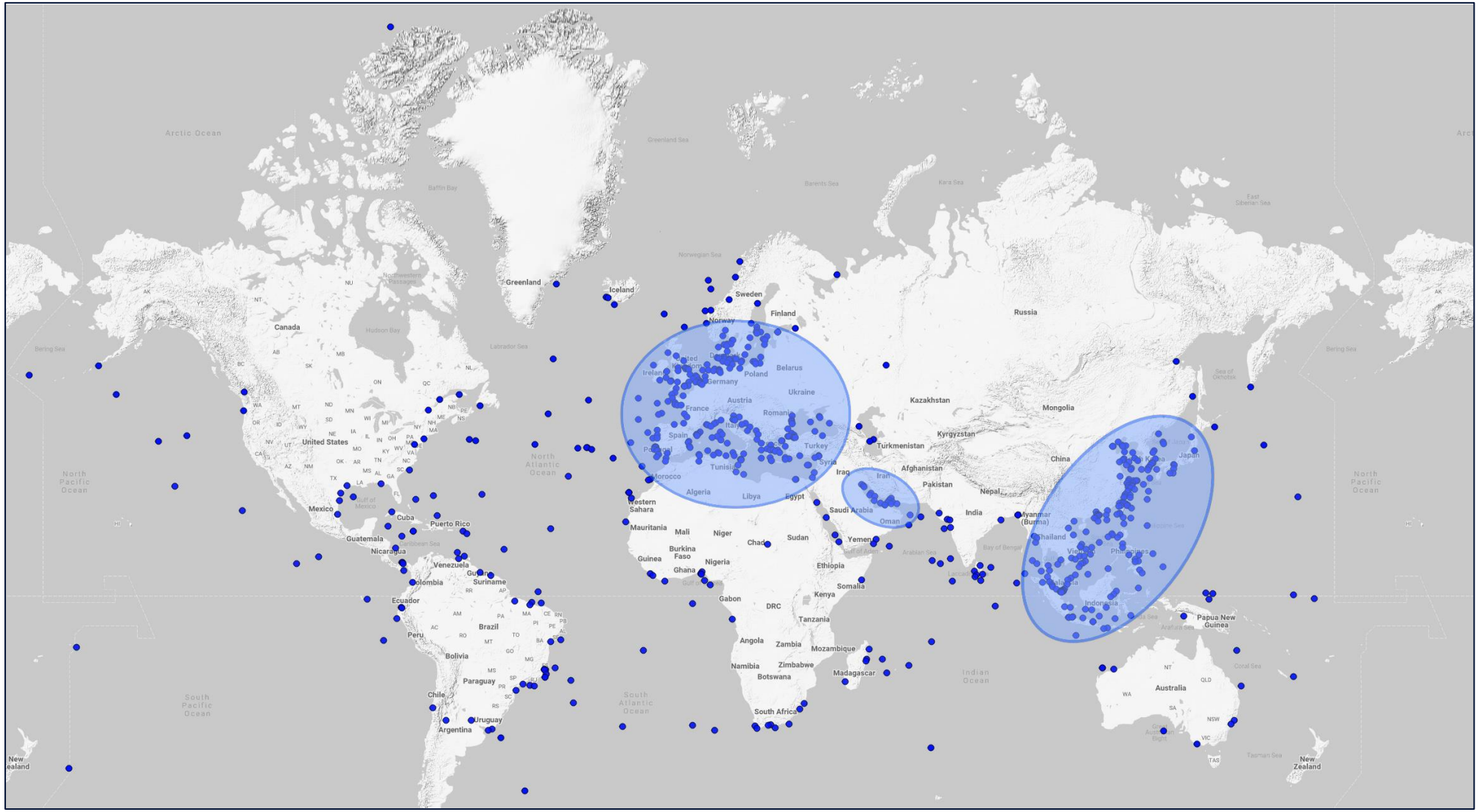


# A nurdle is on board a ship




[11]

# A shipping incident occurs

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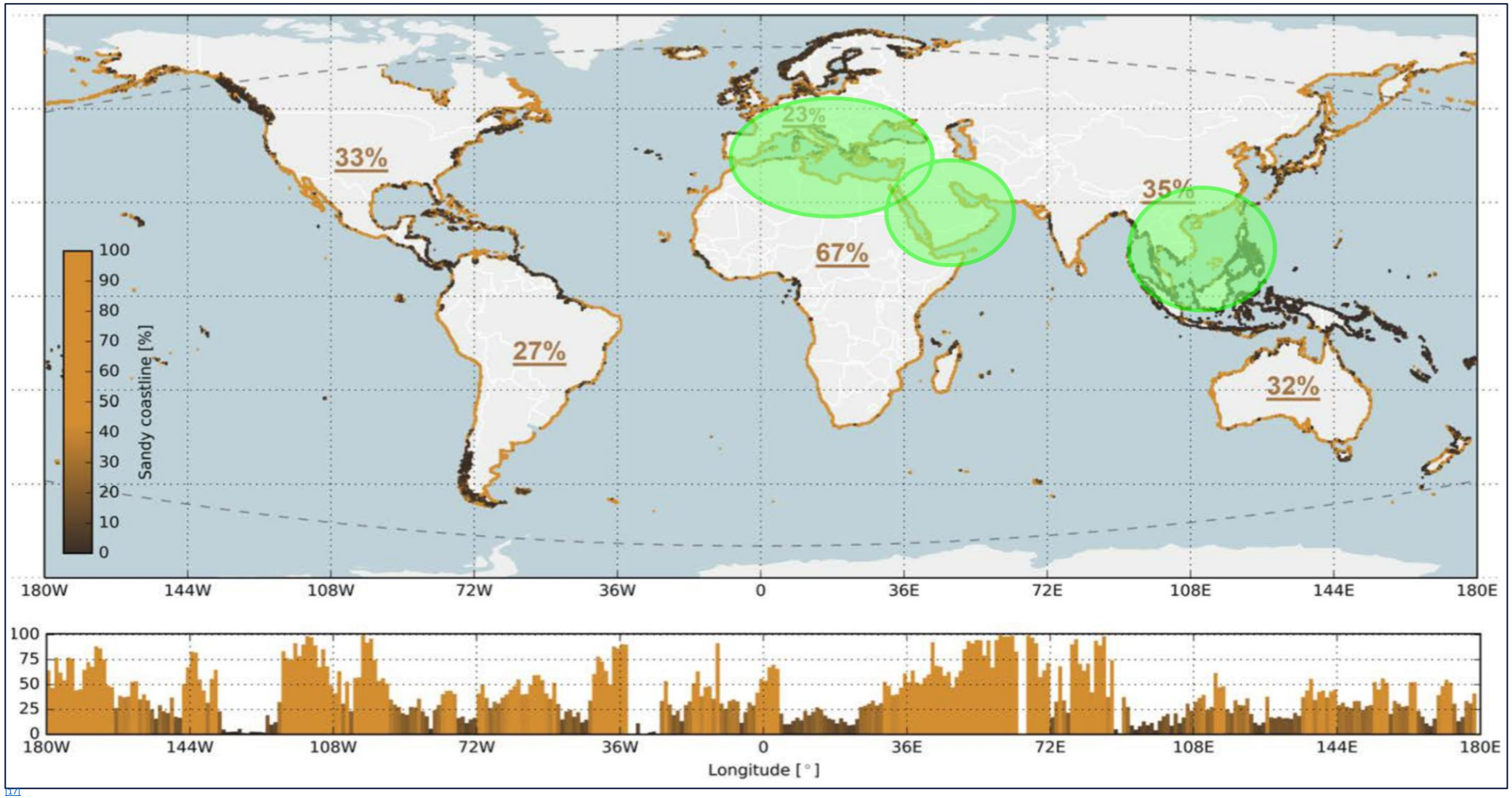
# A Nurdle Spill




[7]

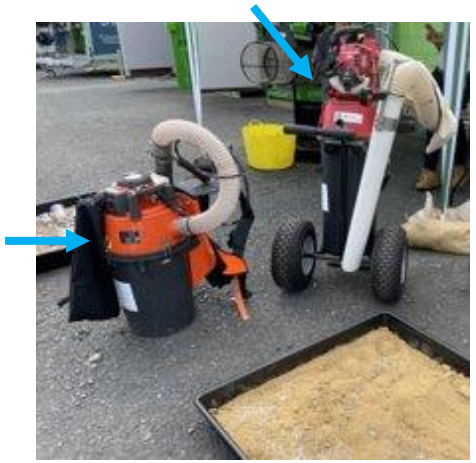
## Aim

Develop **simple**, **accessible**, and **sustainable** novel clean-up **equipment**, for the **collection of nurdle** pollution from **sandy shorelines** in **immediate response** to nurdle spill incidents.

## Objectives

- Research and evaluate current methods of response and technologies to deal with nurdle spill incidents
- Improve the effectiveness of nurdle collection compared to current solutions
- Improve the ergonomics of current designs to reduce injury and increase efficiency
- Minimise the negative environmental impact on the local ecosystem and global environment
- Make the design simple to manufacture and globally accessible

Paddock Cleaner



Overton Backpack Cleaner

Electronic Trommel

## Effectiveness Measures

**Speed** - mass of nurdles collected per second (g/s)

**Purity** - ratio of the mass of nurdles collected to the mass of total matter collected (%)

**Energy** - mass of nurdles collected per kJ of energy used (g/kJ)

Speed- 0.19 g/s
Purity- 1.28 %
Energy- 0.03 (g/kJ)

Speed- 0.43 g/s
Purity- 2.11 %
Energy- 0.11 (g/kJ)

## Collection

### Paddock Cleaner

### Limitations

- Large total mass pickup
- Unergonomic handle
- Large tube area
- Requires a second separation stage
- Noisy engine

## Separation

### Electronic Trommel

### Limitations

- Mesh still allowed broken nurdles to pass
- Gaps in the fittings of the mesh
- Mechanical rotation too quick
- Sand clumps still passed through

**Top Six Design Requirements**

- **Effectiveness**
- **Reliability**
- **Transportability**
- **Low Environmental Impact**
- **Easy to Manufacture**
- **Ergonomic**

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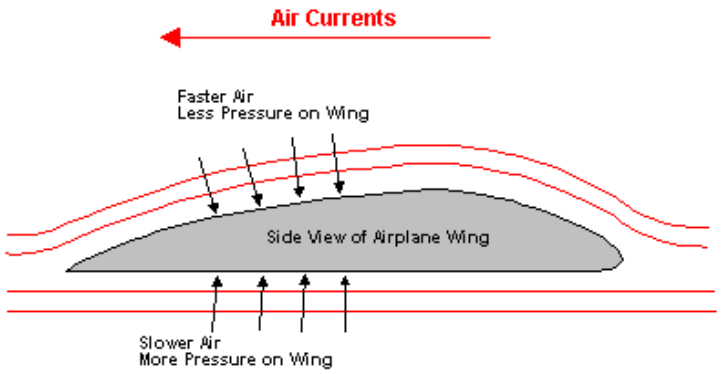
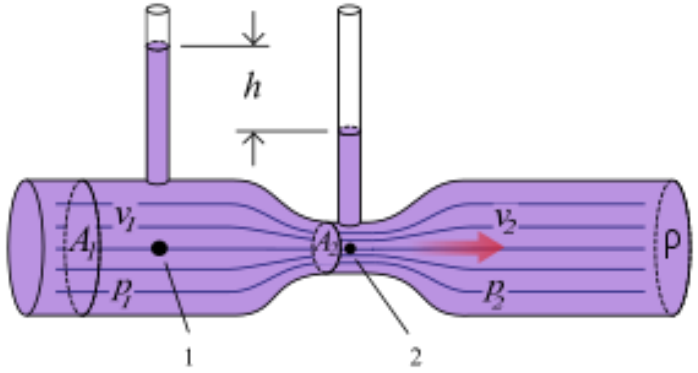
## Bernoulli's Principle




[20]

## The Venturi Effect

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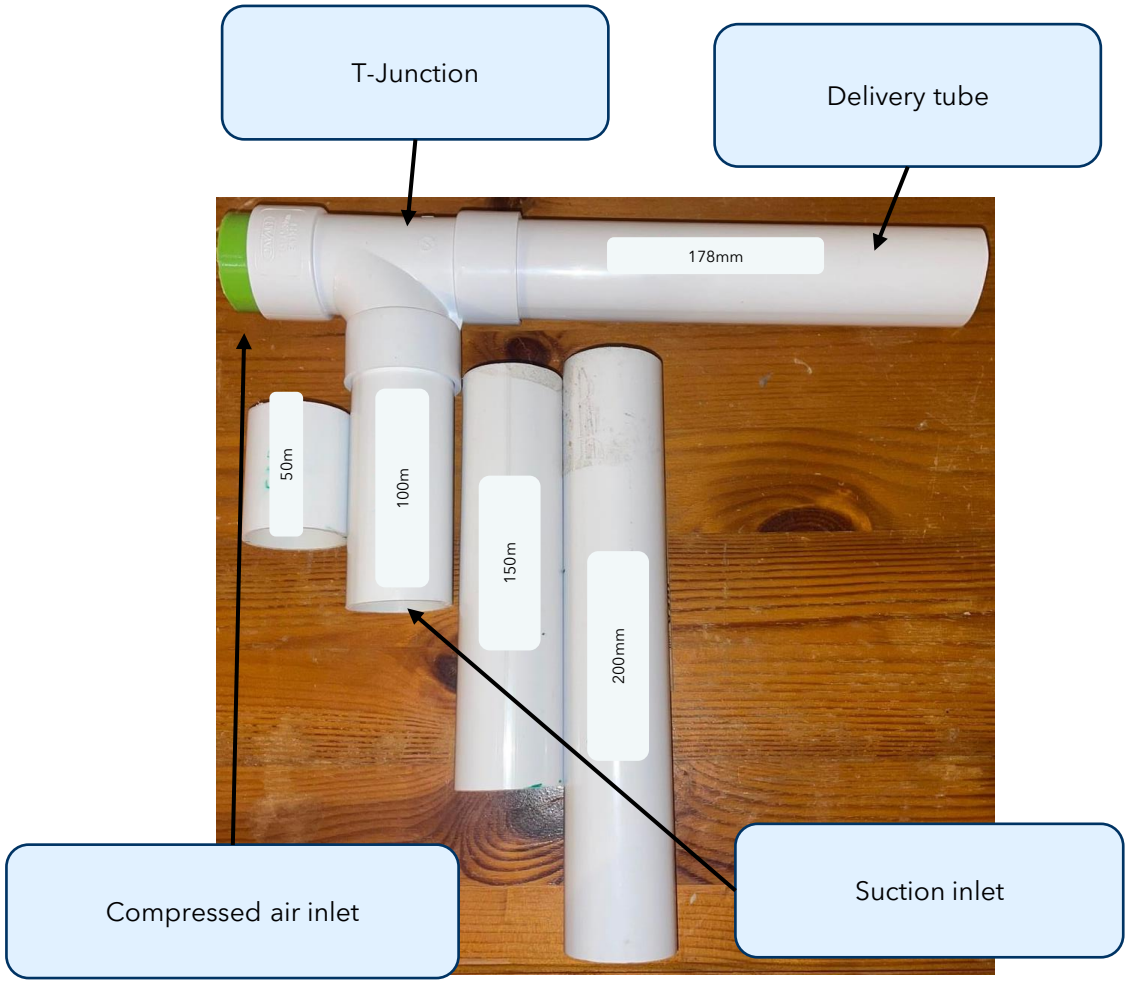
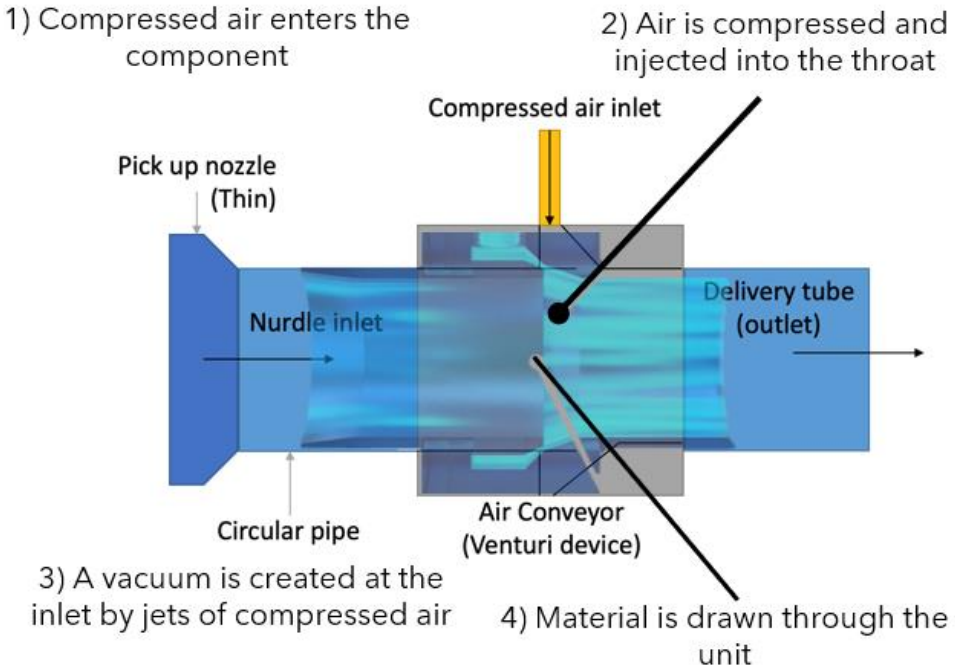


AIRMASTERS

[22]


1) Compressed air enters the component
2) Air is compressed and injected into the throat
Compressed air inlet
Pick up nozzle (Thin)
Nurdle inlet
Delivery tube (outlet)
Circular pipe
Air Conveyor (Venturi device)
3) A vacuum is created at the inlet by jets of compressed air
4) Material is drawn through the unit

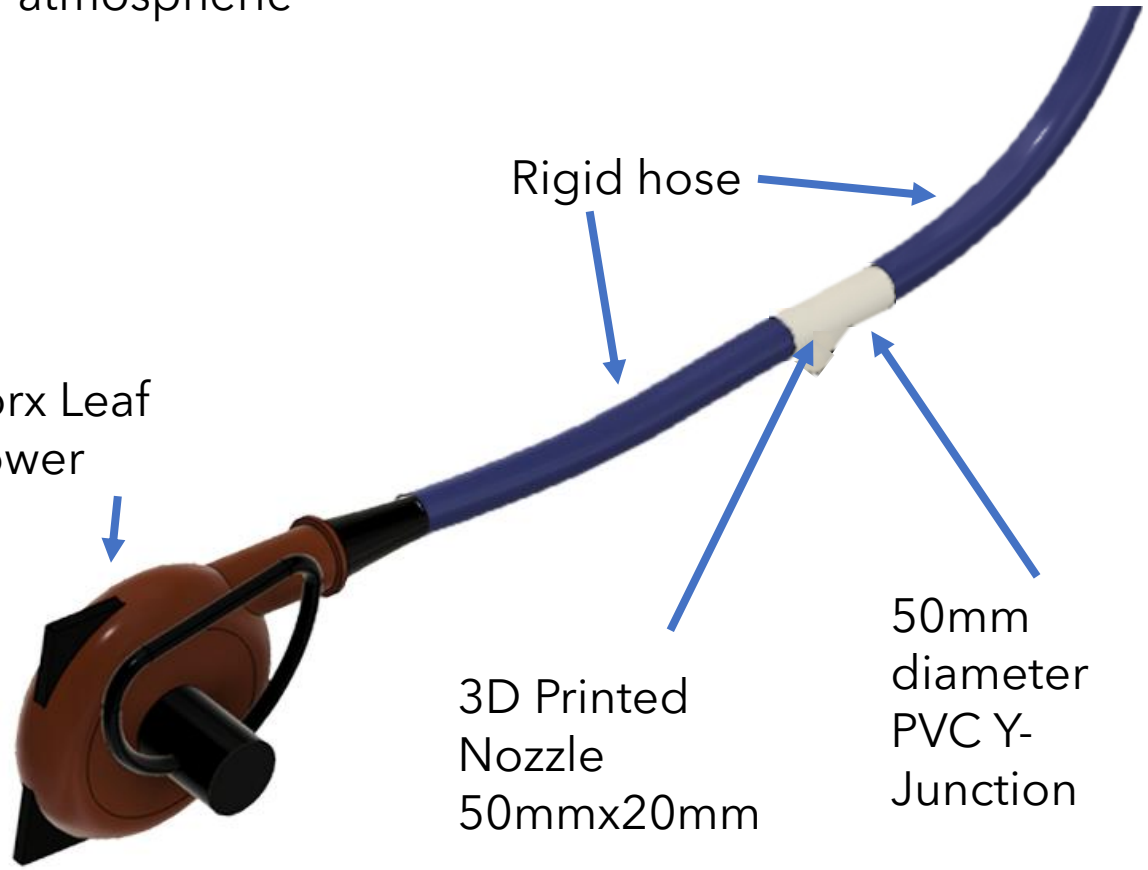
**Leaf Blower**

**Limitations**

- Not compatible with air-operated conveyor
- Weaker suction created with alternative Venturi set-up

**Leaf Blower with Optimised Venturi Nozzle**

- Air speeds from 140-581m/s
- Largest pressure differential of 2.01 bar from atmospheric




**Leaf Blower with Optimised Venturi Nozzle Limitations**

- Rigid hose reduces controllability
- No handle for Y-junction
- Suction angle of Y-junction in relation to surface

0.6 mm mesh

3.35 mm mesh

2 mm mesh

1.18 mm mesh

Mesh Size → Coarseness of Sand → Ratio of nurdles to sand

0.6 mm mesh

3.35 mm mesh

2 mm mesh

1.18 mm mesh

Mesh Size → Coarseness of Sand → Ratio of nurdles to sand

0.6 mm mesh

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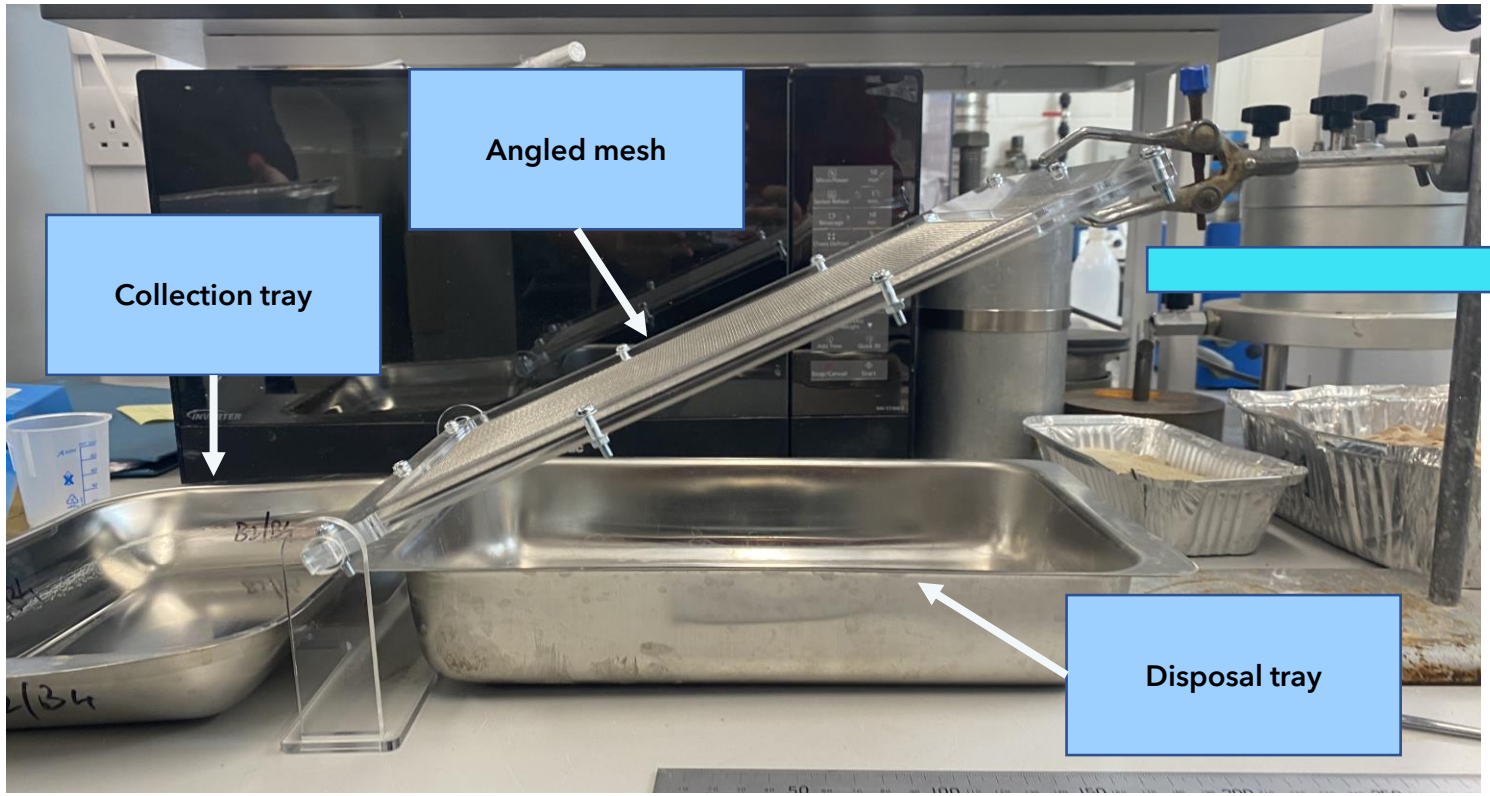
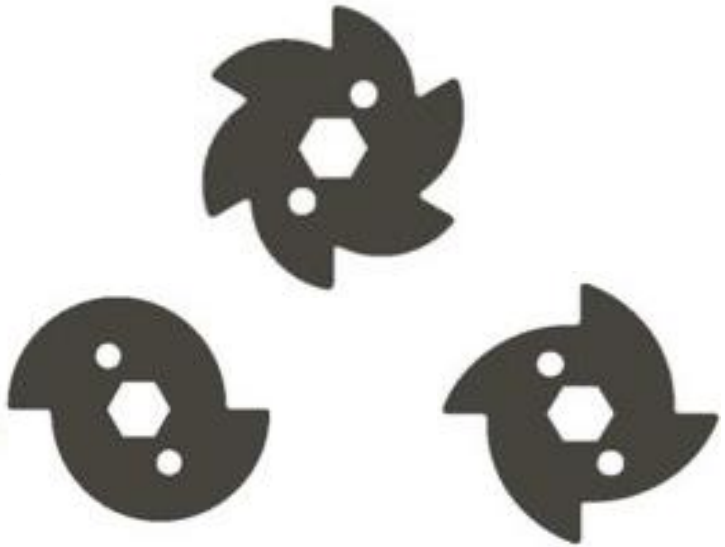
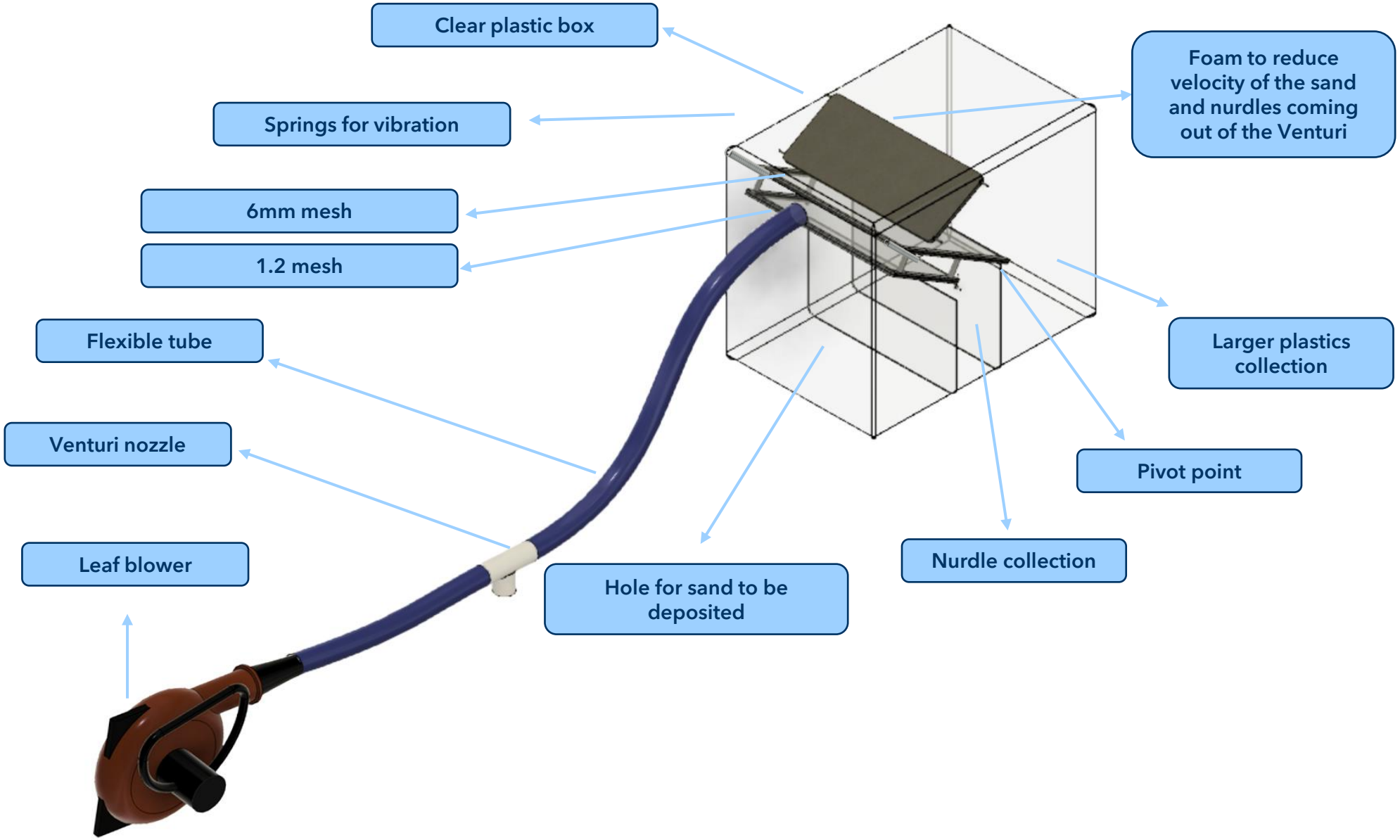
1.18 mm mesh

Mesh Size → Coarseness of Sand → Ratio of nurdles to sand



| Parameter | Value for NNV1 | Value for NNV2 |
|---|---|---|
| Angle of mesh | 25° | |
| Motor speed | 44 rpm | |
| Frequency | 4.64 Hz | |
| Spring constant | 0.3 N/mm | 3 N/mm |


Clear plastic box
Springs for vibration
6mm mesh
1.2 mesh
Flexible tube
Venturi nozzle
Leaf blower
Hole for sand to be deposited
Foam to reduce velocity of the sand and nurdles coming out of the Venturi
Larger plastics collection
Pivot point
Nurdle collection

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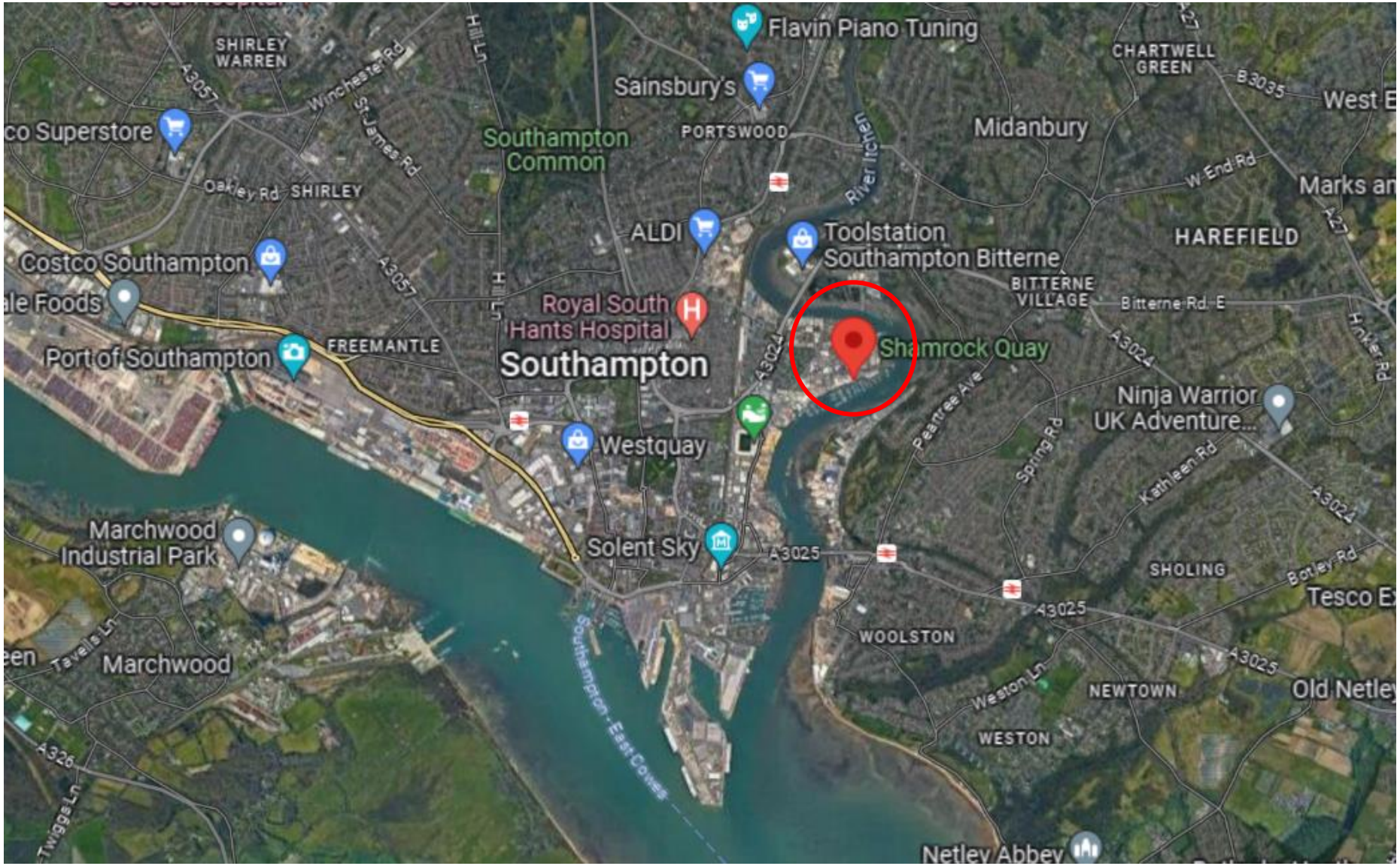
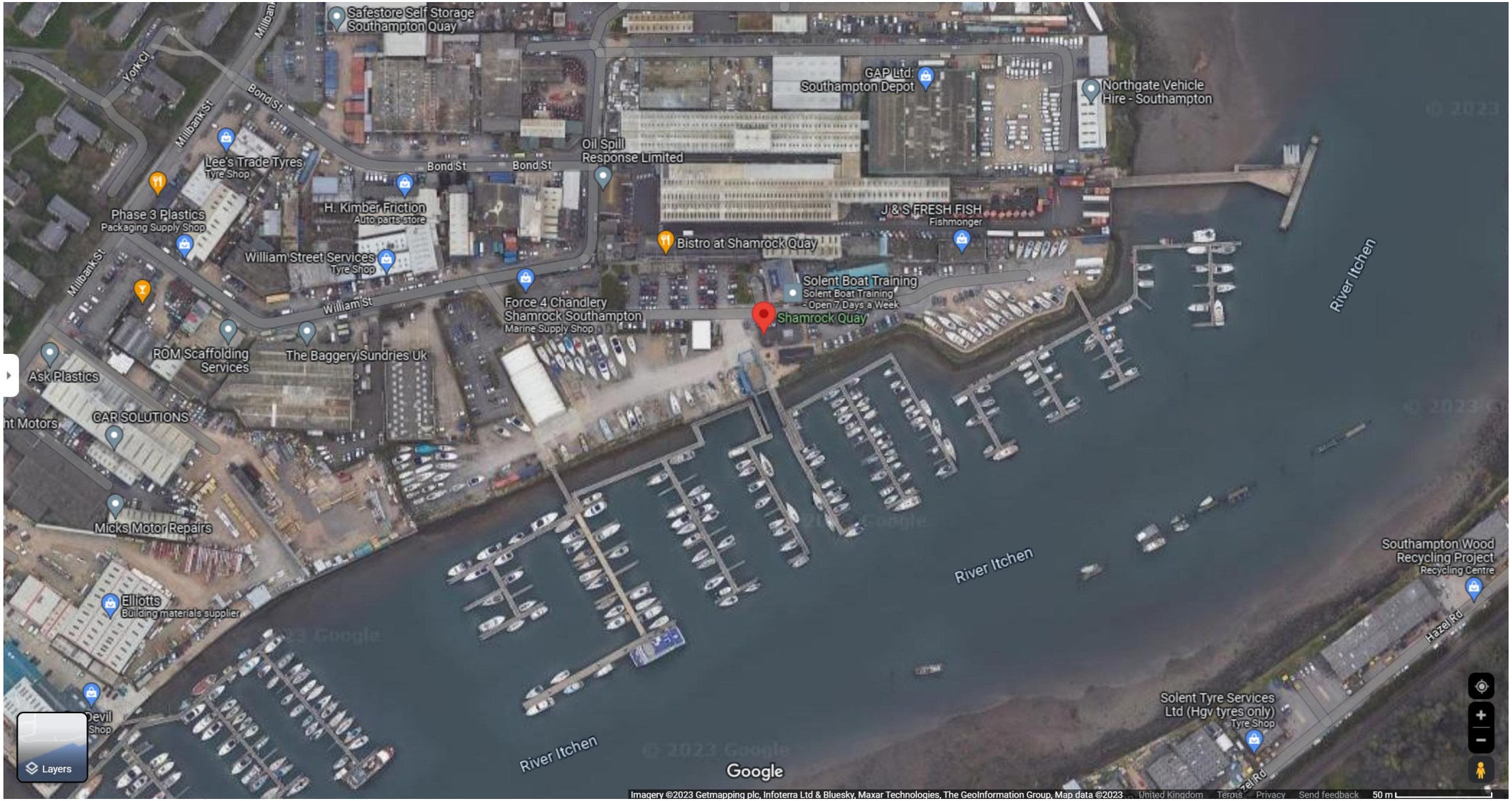

Flavin Piano Tuning
Sainsbury's
SHIRLEY WARREN
Winchester Rd
St James Rd
Hill Ln
A3057
co Superstore
Oakley Rd
SHIRLEY
Southampton Common
PORTSWOOD
River Itchen
Midanbury
CHARTWELL GREEN
B3035
West E
W End Rd
Marks an
ALDI
Toolstation Southampton Bitterne
HAREFIELD
Costco Southampton
BITTERNE VILLAGE
Bitterne Rd E
ale Foods
Royal South Hants Hospital
Shamrock Quay
Port of Southampton
FREEMANTLE
Southampton
A3024
Peartree Ave
Ninja Warrior UK Adventure...
Hinkler Rd
Westquay
Spring Rd
Kathleen Rd
Marchwood Industrial Park
Solent Sky
A3025
SHOLING
Borley Rd
Tesco E
WOOLSTON
Tavells Ln
Marchwood
Weston Ln
NEWTOWN
Old Netley
WESTON
A326
Twiggs Ln
Southampton East Cowes
Netley Abbey

[28]


Safestore Self Storage Southampton Quay
York Cl
Millbank St
Bond St
Lee's Trade Tyres
Tyre Shop
Phase 3 Plastics
Packaging Supply Shop
H. Kimber Friction
Auto parts store
Oil Spill Response Limited
GAP Ltd: Southampton Depot
Northgate Vehicle Hire - Southampton
J & S FRESH FISH
Fishmonger
Bistro at Shamrock Quay
William Street Services
Tyre Shop
William St
Force 4 Chandlery Shamrock Southampton
Marine Supply Shop
Solent Boat Training
Solent Boat Training - Open 7 Days a Week
Shamrock Quay
River Itchen
ROM Scaffolding Services
The Baggery|Sundries Uk
Ask Plastics
CAR SOLUTIONS
Micks Motor Repairs
Elliotts
Building materials supplier
Southampton Wood Recycling Project
Recycling Centre
Hazel Rd
Solent Tyre Services Ltd (Hgv tyres only)
Tyre Shop
Layers
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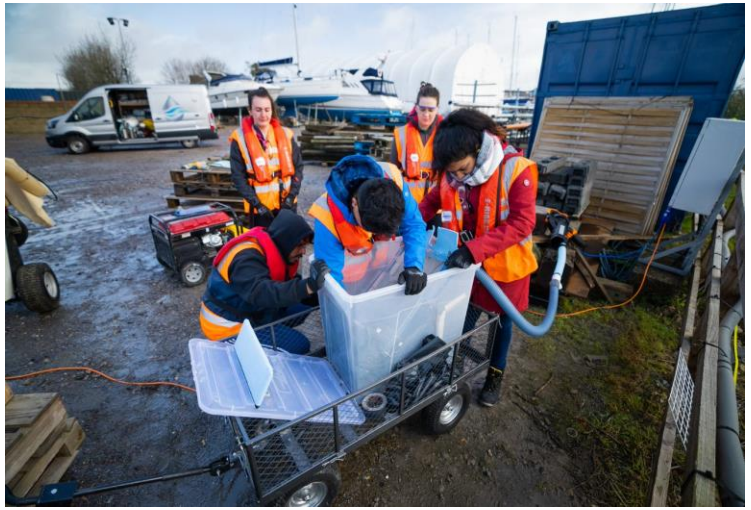
BMT



MAKITA

- Integration of systems
- Nurdles were collected and separated

**Separation System**

- Geometry of box
- Fitting
- Spring connections

**Collection System**

- Ergonomics
- Tubing connections
- Required two operators

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## Collection System

- Ergonomics
- Tubing connections
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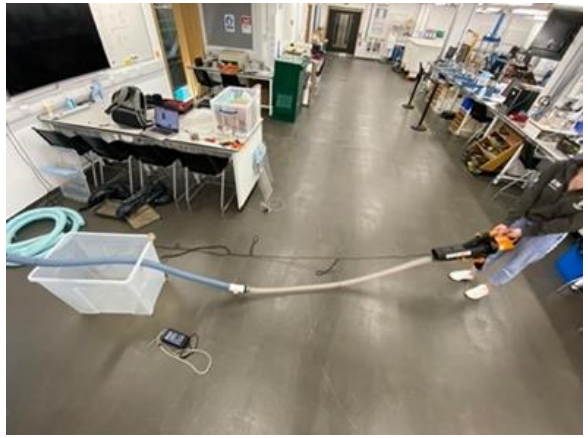
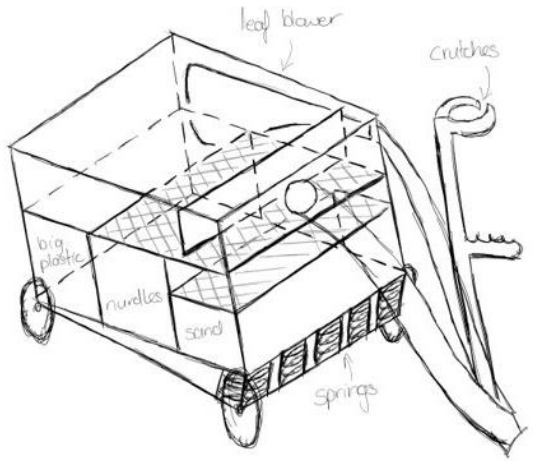
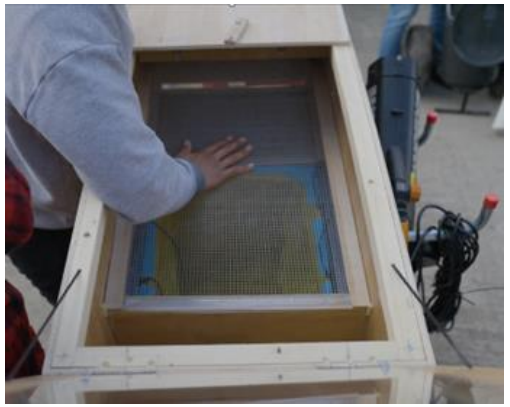
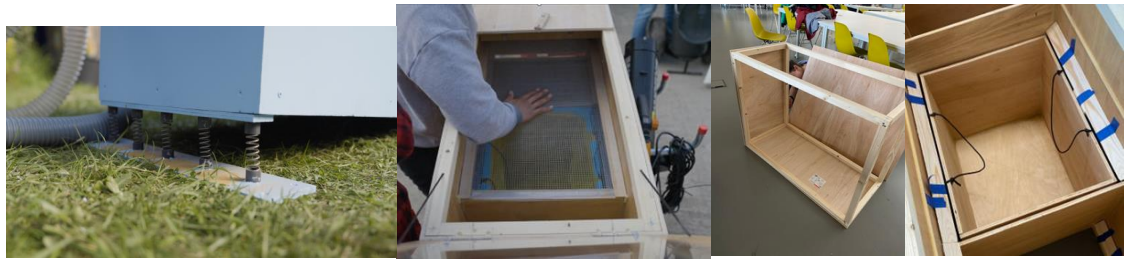





## Separation System

- Geometry of box
- Fitting
- Spring connections





THE NURDLE PROJECT
The Nurdle
Nabber

# THE NURDLE PROJECT

Instructions for the manufacture and operation of The Nurdle Project's Nurdle Nabber v2

A venturi powered plastic nurdle pollution collection and separation system.

ORACLE Environmental Experts

Oil Spill Response ITOPF UK & Ireland Spill Association THE VOICE OF THE SPILL INDUSTRY

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## THE NURDLE PROJECT

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## THE NURDLE PROJECT

General Information: Materials List

| Material/Components | Quantity | Cost |
|---|---|---|
| *2440x1220x9mm plywood* | **2** | |
| *1220x610x9mm plywood* | **1** | |
| *1220x610x5mm plywood* | **2** | |
| *34x34x180mm smooth planed Spruce* | **6** | |
| *6x11x800mm pine strip wood* | **4** | |
| *1.2mm stainless steel mesh* | **1** | |
| *6mm stainless steel mesh* | **1** | |
| *Steel butt hinges* | **Pack of 3** | |
| *3m Ultra Flexible Ducting* | | |
| *1m Semi Flexible Tube* | | |
| *Y-Junction* | **1** | |
| *Crutch* | | |
| *Worx 1440W leaf Blower* | **1** | |
| *50mm Wood Screws (Frame to Frame)* | | |
| *20mm Wood Screws (Panel to Frame)* | | |
| *Wood Filler* | **1 tub** | |
| *Silicon Sealant* | **1 tube** | |
| *10mm Steel rod* | | |
| *Rubber wheels* | **4** | |
| *Compression Springs* | **Pack of 5** | |
| *Thin cord* | **1.5m** | |
| *Foam* | **1m2** | |
| *Staples and Staple Gun* | **1 pack** | |
| *PVA glue* | **1 bottle** | |
| *UHU Adhesive* | | |
| *Tool hooks* | **2** | |
| *20mm ID PVC pipe* | **1m** | |
| *Jubilee clips* | **Pack of 10** | |
| *Knock Down Block Fitting* | **2** | |
| *Fence paint* | **2.5l tin** | |

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## THE NURDLE PROJECT

Cut List:

CN – Component Number

| Material | CN | Description | Quantity | Dimension | Cut Out? |
|---|---|---|---|---|---|
| 9mm Plywood | 1 | Large outer panel | 2 | 1020x778mm | |
| | 2 | Small outer panel | 1 | 450x778mm | |
| | 3 | Box base panel | 1 | 450x1000mm | |
| | 4 | Small outer panel with inlet hole and mesh slots | 1 | (50mm inlet hole in centre) | |
| | 5 | Small outer panel with inlet hole and mesh slots | 1 | | |
| | 6 | Small outer panel with inlet hole and mesh slots | 1 | | |
| | 7 | Flip up lid | 1 | 470x660mm | |
| | 8 | Fixed lid | 1 | 470x360mm | |
| | 9 | Large plastics collection box - short side | 2 | 166x300mm | |
| | 10 | Large plastics collection box - long side | 2 | 450x300mm | |
| | 11 | Large plastics collection box - Base | 1 | 166x432mm | |
| | 12 | Nurdle collection box - Sides | 4 | 450x550mm | |
| | 13 | Nurdle collection box - Base | 1 | 450x450mm | |
| | 14 | Plastic separation wall | 1 | 600x450mm | |
| | 15 | Nurdle separation wall | 1 | 450x500mm | |
| | 16 | Foam panel | 1 | 450x120mm | |
| | 17 | Mounting Panels | 2 | 550x100mm | |
| 5mm Plywood | 18 | Large mesh | 2 | 450x800mm | |
| | 19 | Small mesh | 2 | 450x350mm | |
| 34x34mm smooth planed Spruce | 20 | Frame short side | 4 | 450mm | |
| | 21 | Frame long side | 4 | 932mm | |
| | 22 | Vertical frame batons | 4 | 700mm | |
| | 23 | Large mesh Ramp | 2 | 800mm | |
| | 24 | Nurdle box ramp | 2 | 470mm | |

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## THE NURDLE PROJECT

| | | | | | |
|---|---|---|---|---|---|
| | 25 | Small mesh ramp | 2 | 350mm | |
| | 26 | Long sides | 3 | 1100mm | |
| | 27 | Short Sides | 4 | 440mm | |
| 10mm steel rod | 28 | Wheel axles | 4 | 150mm | |

Required Tools

- Saw (Manual or band saw)
- Hand Drill
  - 2.5mm drill bit
  - 50mm Hole saw
  - 20mm drill bit
- Screwdriver
- PVA Glue
- UHU Adhesive
- Masking Tape
- Stapler and Staples
- Nail Gun or Nails and hammer
- Wood filler
- Metal Scraper
- Paint brushes or roller

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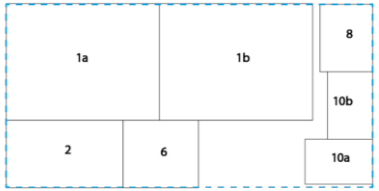
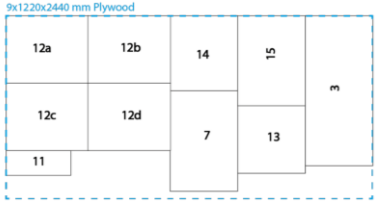
## THE NURDLE PROJECT

Material Tessellation Guide

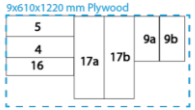
9x1220x2440 mm Plywood




9x1220x2440 mm Plywood




9x610x1220 mm Plywood

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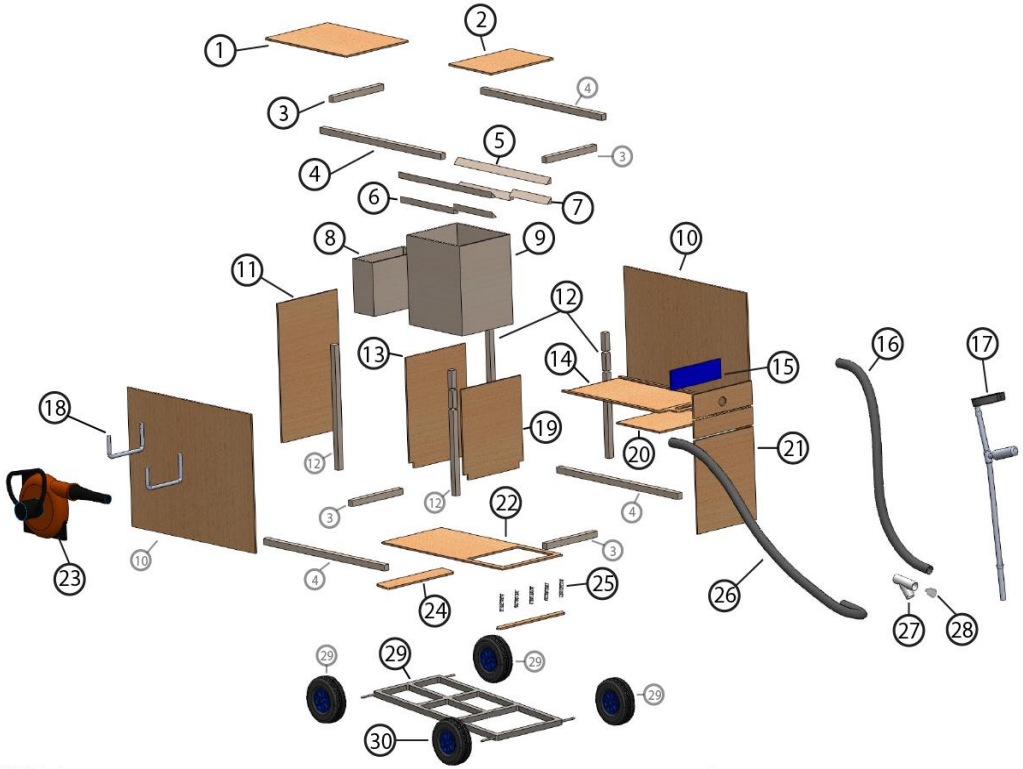
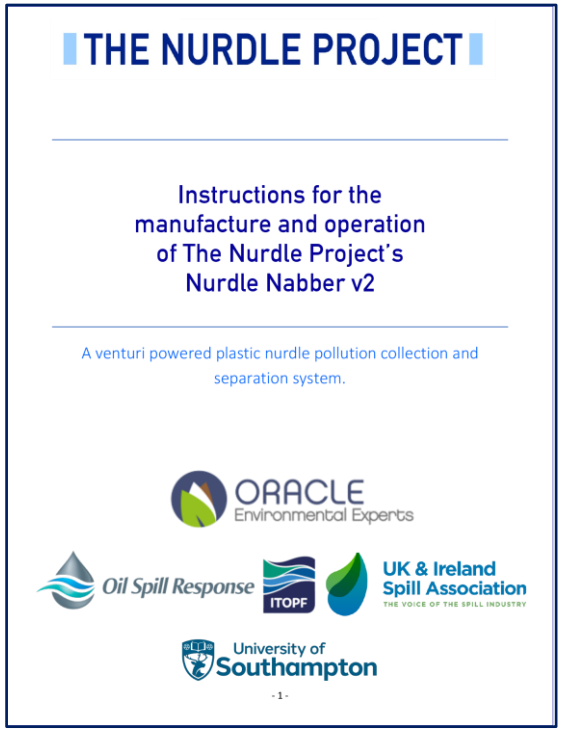
## Open-Source Instructions Manuals





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1

Design Report
FEEG6013 Group Design Project

35

**The Nurdle Project**

*Design of equipment for cleaning shorelines of plastic nurdle pollution*

Nearly all plastic products are manufactured from plastic pellets called nurdles, which are approximately 5mm in diameter, and transported by container ship. However, accidents during transportation can cause nurdles to enter the ocean, where their toxins contaminate the water and they enter the food chain when mistaken for food by wildlife. They accumulate on beaches, harming ecosystems so recovering these nurdles without causing further harm to the environment is crucial.

Collaboration with industry stakeholders such as the Plastic Pollution Working Group and the Maritime and Coastguard Agency was vital for determining the design requirements and initial research was important in this process due to the limited selection of equipment currently available. Two sub-teams investigated the optimal methods for collecting nurdles and separating them from sand and other debris. This was done through the aid of CAD, iterative prototyping and CFD simulations. Testing was undertaken throughout the process to ensure the effectiveness of equipment produced.

It was decided that material would be picked up using the Venturi effect, implemented using a leaf blower and specially adapted nozzle and that separation would occur through a series of meshes so sand could be returned directly to the beach. Equipment was integrated into a final concept, the Nurdle Nabber, so that these processes could occur simultaneously. This novel machine is simple, accessible and outperforms competitors in effectiveness. It achieves all the design requirements and assembly instructions are freely available so that it can be produced anywhere in the world using materials sourced locally to ensure a fast and efficient response to nurdle spills.

Group Members:

| ID Number | Name | ID Number | Name |
|---|---|---|---|
| 31501613 | Sowmiya Aravinthan | 31032125 | Nirushaan Srithar |
| 30922038 | Amy Kerrison | 30998298 | Sajal Rana |
| 30809525 | Jack Searson | 30852714 | Eleanor Winterburn |

Primary Supervisor: Dr. James Blake

Co-Supervisor: Prof. David White

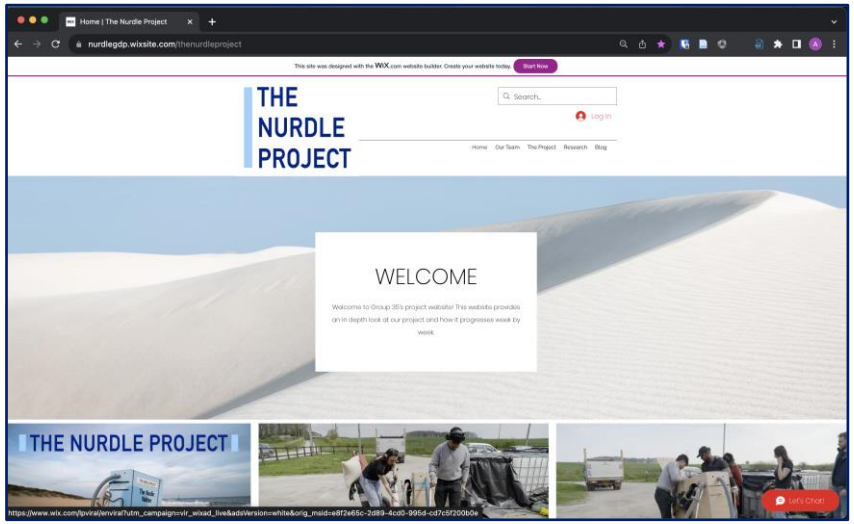
Submitted on: 10/05/2023

THE NURDLE PROJECT

Oil Spill Response

UK & Ireland Spill Association

THE VOICE OF THE SPILL INDUSTRY



01

Using maritime data to predict the locations of future nurdle spills

By Amy Kerrison

PDF

02

Collection tests

By Jack Searson, Saj Rana, Niru Srithar

PDF

03

Separation tests

By Sowmi Aravinthan, Ellie Winterburn

PDF

04

Angled Sieving Tests

By Amy Kerrison and Sowmi Aravinthan

PDF

# THE NURDLE PROJECT

Team Members Left to Right:
Sowmiya Aravinthan, Sajal Rana, Amy Kerrison,
Nirushaan Srithar, Eleanor Winterburn, Jack Searson

## Thank you for listening!

## Any questions?

Website Link: