Introduction

When we wanted to choose a challenge, we recognized ourselves as a team formed and based on very important concepts such as teamwork and camaraderie; Then, we understood what we could do for the planet this is why we chose trash cleanup. Then, when designing and proposing the resolution of the problem, we saw the urge to have an impact on society, encourage social values, and work to preserve life on the planet. To achieve this, we investigated the consequences of pollution in oceans.

Different stool samples from people from distant countries such as the United Kingdom, Italy, Russia or Japan contained polyvinyl chloride (PVC), polypropylene, polyethylene terephthalate particles. Although this is a pilot study with a small group of people, the geographic diversity of the participants and the types of plastic identified leads the authors of the research to highlight the urgency of determining the impact of these materials on human health.

These wastes came from water and the action of water, microorganisms and sunlight were degrading the plastic to reduce it to small particles of a few microns in length. A very important conflict is that some of the animals in the ecosystem are so small that it confuses them with food.

Then, we created TrashWhale, a non-tried manned submarine; Given its filtering system which includes 5 sieves it's possible to reach the final goal of collecting the contaminating residue produced by human waste, with this task. The challenge of sweeping with the previously determined zones guiding itself by GPS technology. In consideration of any failure within the first of all the sieves it will activate an emergency protocol and we will start the manual procedure to be able to find it, clean it and continue with its programmed routine. The final goal: cleaning of microplastic, which is harmful to our environment.

Its infrastructure makes it able to carry up to 38 kg (83.7757 pounds) of microplastic distributed between its sieves, this gives TrashWhale the necessity of a great variety of sensors which are needed to control the submarine. This benefits our efficacy at the time of taking care of the task without needing that much personnel. The sensor will also make easier the capacity of being autonomous to correct its deviation automatically and avoid collisions with objects such as, fishing nets, plastic bags, animals, etc.

How it works?

Taking in consideration that the submarine is designed so it is not necessary to crew it personally, it is programmed to follow a routine (which is programmable) and giving GPS satellite position, stabilizing using a gyroscope and thus being able to complete the cleaning of a certain assigned area.

To understand its mechanism, we designed the following diagrams:

1- Flowchart (image)

By having an unmanned submarine, you need to have commands; The following diagram shows which is the logical processing of the planned drivers.

2- Internal infrastructure

Inside the submarine, we designed 3 sieves and 2 sponges, which gradually filters all the macroparticles that could enter the submarine through its frontal cavity. Here we detail the specification corresponding to the 5 filters.

Sieving system:

1ST SIEVE:

Its functionality it's to avoid big objects and animals get inside of the filtering system and it counts with specifications:

- stainless steel- AISI 316 Sieve.
- Nominal openings: 0.38 mm,
- Diameter of threads: 0.25 mm,
- Threads / inches: 40x40,
- Open surface: 37%,
- Kind: plain fabric.

2ND SIEVE

After the first sieve, the objective of the second one it's to filter even smaller particles, so on the size of the next 3 sieves goes smaller and smaller.

- Stainless steel - AISI 316 Sieve,
- Nominal Opening: 0.103 mm,
- Thread Diameter: 0.066 mm,
- Thread / inches: 150x150,
- Open surface: 37%,
- Kind: plain fabric.

3RD SIEVE:

- Stainless steel - AISI 316L Sieve,
- Nominal Opening: 0.01 mm,
- Thread / inches: 325x2300,
- Fabric: Crossed Dutch

4TH SIEVE (FOAM):

- Stainless steel - AISI 316 Foam,
- Thickness: 6.35 mm,
- Gross density: 0.55 g.cm-3,
- Porosity: 93%,
- Pores / cm: 24

5TH SIEVE (FOAM):

- Stainless steel - AISI 316 Foam,
- Thickness: 12.7 mm,
- Gross Density: 0.55 g.cm-3,

- Porosity: 93%,
- Pores / cm: 24

3- Command

TrashWhale must be pre-programmed with precise coordinates, coming from its satellite position via GPS; In this way, the submarine becomes independent of any human control.

The coordinates must be precise so that it can be oriented in altitude, longitude and depth; Inside the ocean ; When you need your geolocation, you can access the mobile application, from any Smartphone, Tablet, notebook device; and you get the location.

In case of emergency, the submarine has the following sensors:

* 1-Submergible Ultrasonic
* 2-Bluetooth (For the controls by the App)
* 3-Camera
* 4-Gyroscope
* 5-Accelerometer
* 6-Relay (Propeller Motor)
* 7-Current pass sensor
* 8-Barometer
* 9-GPS GPS6MV2
* 10-Submersible Proximity Sensor

Understanding this, we can propose that, in case of emergencies, the person in charge (located on the mother ship) can access in the same app and visualize which sensor was the one that was triggered and what was its cause. After this, decide whether to access the manual control or not. In case of activating manual operation, the operator will be able control the position and movements of the submarine.

4- Submarine's Location

The submarine´s location will be determined by an initial position, the surface ship, and it will triangulate via satellite (GPS). We´ll need to use the next physics equation:

$$x_f = x_i + v_i\, t + \frac{1}{2}\, a\, t^2$$

Since, with the acceleration sensor of the submarine, it would already be a fact like time, the speed that would only imply integrating the acceleration formula in relation to time.

As for the gyroscope, through integration we will obtain the angle with its components in three dimensions (X, Y, Z)

$$\omega = \frac{\delta\theta}{\delta t}$$

$$\omega . \delta t = \delta\theta$$

$$\int \omega . \delta t = \int \delta \theta$$

$$\frac{1}{2}\omega t^2 = \theta$$

Taking in consideration the three-dimensional data obtained by the gyroscope, multiplying the previous equation by the axis unitary vector, according to the received data, the vector θ = (θx; θy, θz) will be obtained, which will indicate the rotation of the submarine under the Water to correct the trajectory in case of any deviation.

In terms of depth, it´s location will be determined thanks to the implementation of a digital manometer which will indicate the seawater pressure and with a simple deduction will allow us to know the depth of the submarine. Besides, its data will be useful to determine the total weight of the already collected plastic and the used percentage of capacity of our submarine. When the submarine is starting to fill up it will release water kept on its inside to keep pressure balance.

5 – Software

The route of the submarine it's programmed with an algorithm which uses data from its sensors to correct its trajectory in case of any detour or encountering any obstacles. It's also going to calculate its exact location using the before cited equations.

Our system will perform inputs and outputs of information to the NASA servers with the objective of creating statistic maps of concentrations of microplastics taking in consideration the ocean currents to use in further work with TrashWhale and scientific investigation.

It's going to be connected to the Google Maps (from the ship) and Google Cloud APIs to give more information and facilitate the submarine's navigation (utilizing the accelerometer) besides from issuing alerts in case of emergency.

This system will also grant the possibility of manual navigation in case of emergency.

The graphic interface of the software will display on screen:

- Real time location using the Google Maps' API in reference with the location given from the accelerometer.
- Submarine's radar.
- Submarine's frontal camera.
- Sensors' state.
- Engine state.
- Rudder's inclination angle.
- Oceanic satélite view.
- Oceanic weather.
- Traveled and further route.
- Available capacity.
- Emergency manual navigation button.
- Satelite conection status.

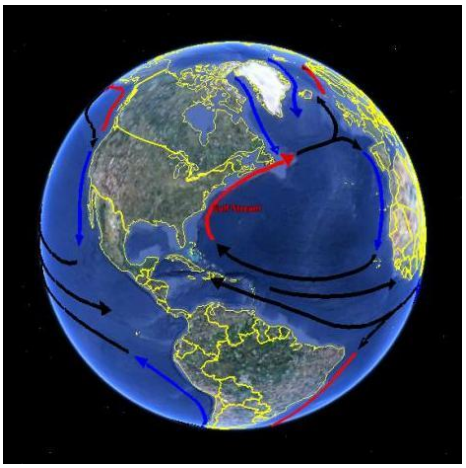
6- Power source

The main energy connection comes from a mother battery located in the control center, the ship on the surface. It transmits enough energy through wires, so that the submarine is always connected, and its task is not interrupted due to lack of energy.

Avoiding pollution and environmental care is very important for TrashWhale; Therefore, we decided to use lithium batteries. These energy sources are rechargeable, this means that the coverage and preservation of the battery must be kept in perfect condition; and thus provide energy to TrashWhale.

On the other hand, in case of not receiving energy from the mother source, the power of a battery, of lower voltage, will be automatically activated inside the submarine; also jumping an alert in the app, announcing the power error.

Where



The NASA Physical Oceanography Program assists in the study of plastic pollution of the ocean in a number of ways. With present satellite technology it is nearly, if not impossible, to detect from space plastic in the ocean. If dry and if large enough, plastic would have a sufficiently unique spectroscopic signature that remote sensing might be possible. However, most plastic and debris in the ocean is neither large nor dry, precluding direct detection. NASA Earth observation assets are mainly used to track the surface currents and wind responsible for the movement of marine debris.

What

The problem for the ocean is that about 8 million metric tons of plastic are estimated to enter the ocean each year. It is thrown away, washed away, blown away, and generally forgotten as it disappears into the ocean.

It is necessary to recycle waste of size less than or approximately equal to 1 micron. For them, we must detect what type of waste we are going to find; in large proportion, we find microplastics and scrap remains that have already begun to disintegrate, although Science cannot explain (yet), among many things, it is the mechanical and chemical degradation of plastic to microplastics, the fate of plastics and waste in the marine ecosystem, or fully identify the sources of all plastics found in the ocean.

Future plans

Understanding that in the first instance the project is planned with a single submarine; We plan on in short and medium term, establishing a fleet using collected and recycled plastics.

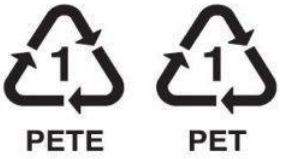
Thus, establish a relationship that benefits different entities; Achieving participation and agreements that generate added value to the final product.

Plastic selection and recycled

1) Recycled Plastics

Here are different uses for recycled plastics and the type of plastic that is obtained after the recycling process.

* Pet plastic



It is recycled into clothing and textile parts, carpets, canvases, threads and ropes.

* High density polyethylene plastic

It is recycled in other containers dedicated to detergents, shampoos, bottles for oil or other industrial uses, plastic tubes and containers, tables and structures.

* Polyvinylchloride plastic

It is recycled in outdoor furniture and other plastic structures such as cabinets, plumbing pipes, fences, part of carpets, electrical equipment and cones.

* Low density polyethylene plastic

It is recycled in garbage bags, waste bags, containers, plastic planks and fiml for agricultural use.

* Polypropylene plastic

It is recycled in boxes and containers for medicines, for transport, in plastic chairs and some garden furniture, battery boxes, cables, brooms and mop buckets, boats and some tools.

* Polystyrene plastic

It is recycled in plastic pots, thermal insulation, thermometers, covers, garbage cans and some office accessories.

Even though, there are some derivatives and types of plastics that do not support the recycling process; in proportion, they are very few since in general, the majority can be recycled.

As an alternative to the destination that can be given to recycled plastic, it could be destined to organizations that can use them for experiments or uses for the common good.

"… Today's vehicles on average contain 50 percent plastics by volume — but only 10 percent by weight."

Also, we notice that brands such as Ford, Honda and more, have among their main materials, recycled plastic; So we also see the opportunity of selling recycled plastic viable, and then, with those gains, to continue creating new submarines and make the fleet grow even more.

Here we have a list of known companies that could be plastic buyers; according to the use observed in their products.

Ford

Uses recycled plastics to create upholstery for passenger seat cushions in numerous models. For example, the seat fabric for each Focus is made with approximately 22 plastic water bottles. The company used more than 50 million pounds of post-consumer recycled plastics on the exterior of Ford vehicles made in North America — that equals nearly 18 pounds per vehicle on average. In the U.K., Ford also collects damaged bumpers to make plastic materials for replacement bumpers.

Sling

Recycles scrap bumpers generated during the manufacturing process. Plastics from bumpers produced at five Honda plants in the U.S. and Canada are reformulated and reused in Honda's supply chain to make mud and splash guards.

General Motors

Uses air deflectors (used to direct air flow) for its Volt made from plastic caps, bottles, and other recycled materials. The company also uses plastic caps and shipping aids from its Fort Wayne facility to make radiator shrouds (used to protect the radiator) for the Chevrolet Silverado and GMC Sierra pickups built at that facility.

Nissan

Uses plastic fibers made from used bottles as the main component in sound insulation layers in dashboards. The automaker also uses plastics recycled from bumpers to create new bumpers, as well as plastics recycled from bottle caps to make new auto parts.

Toyota

Use recycled plastics throughout its vehicles. The company recently announced that 20 percent of the plastics used in its vehicles are made with recycled plastics or derived from plant materials.

Adidas

Shop Parley shoes and apparel

Parley for the Oceans is an organization dedicated to addressing the threats against our oceans. In a well-known collaboration with Adidas, the two launched shoes and apparel that fuse Adidas' famous performance tech with sustainable materials. Each sneaker repurposes approximately 11 plastic bottles intercepted before they could enter the ocean. The colorways mimic the environments they seek to protect - seafoam blues, deep greens, and a spectrum of navy. Adidas' goal is to phase recycled plastic into all of its shoes by 2020.