Co-funded by the
Erasmus+ Programme
of the European Union

THE PEDAGOGICAL SAILBOAT

IO2 -B
Construction of a microplastics sampling instrument

Introduction

Pollution by microplastics is a major global problem. Microplastic pollution is a relatively new area of research and the impact of microplastics on the marine environment remains poorly understood. To understand the threats to aquatic ecosystems, the level of distribution and contamination of microplastics must be studied. For this season the scientific community is carrying out microplastic sampling campaigns on the surface and at the bottom of seas and oceans and also in rivers and lacs.

Microplastics sampling activities on the sea surface are often carried out with a manta net as part of citizen science projects.

The manta net is the most used sampling instrument for the sampling of microplastics. The manta net got its name because it incorporates some of the adaptations of the fish of the same name Manta Misantris whose shape allows it to capture prey on the surface (Figure 1).

Students of the Athénée Royal Louis Delattre (technological education) have been asked to construct a 'manta net' that can be used to carry out a sampling campaign at sea aboard a sailboat.

Figure 1 Manta birostris, the design of the sampling instrument is basedon the sgape of this fish (photo Wikipedia)

MICROPLASTICS

Plastic particles that are less than 5mm in size.
Microplastics are divided into different categories including fibers, pellets, fragments,granules and films Figure 2

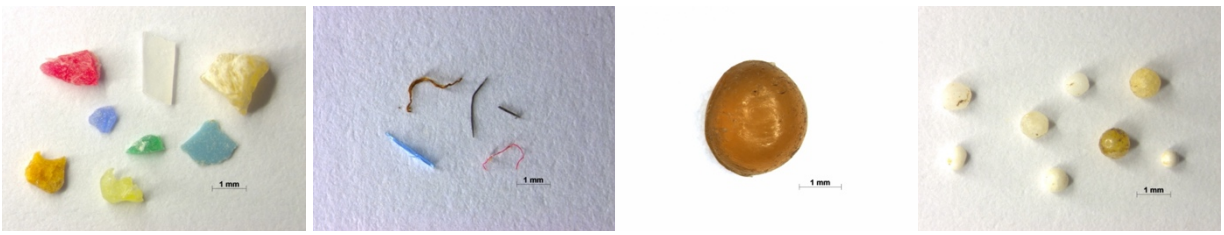


Figure 2 different types of microplastics fragments, fibers, pellet and granules

Figure 3 The schooner "Tirant Primer". The researchers will perform the microplastics campaigns onboard this 28 meters length sailboat

Educational objectives

Identify the different parts of the scientific instrument for sampling microplastics (manta net).

Realise a reduced model of the frame using diagrams and sketches

Carry out sheet metal cutting, forming and assembly activities to construct a manta net.

Learn to select and handle tools the appropriate tools and equipment correctly, and check that they are in a safe and usable condition

Comply with safety and health organisational policies and guidelines.

The manta net

The manta net is composed of a semi-rectangular frame to which is connected a conical net of about 3 meters length with 300 to 333 microns mesh size (note that scientists have not yet developed any standard in this regard). Two wings are connected to the frame to hold it on the surface when and exert lift that compensates for the downward pull exerted by the net (Brown & Cheng, 1981). The microplastics are caught at the back of the net in a PVC collector. The upper edge should remain continuously on the sea surface throughout the sampling period in order to produce valid quantitative data (dashed lines in Figure 3)

Function of the manta net

The scientists use the manta net to collect microplastics continuously from the first 20 centimetres below the water surface. The volume of filtered water can be estimated reasonably accurately if the sampling instrument maintains its position. If the wave height exceeds a certain level, the net will tend to jump over the surface of the water and for this reason, the samples are taken in calm seas. The net is towed for about 20 minutes using a steel cable. We can thus calculate the number of particles per unit volume of filtered water. The speed of the boat towing the net should be between 1 and 3 knots. A sampling protocol can be viewed at the following link: www.jove.com/t/55161

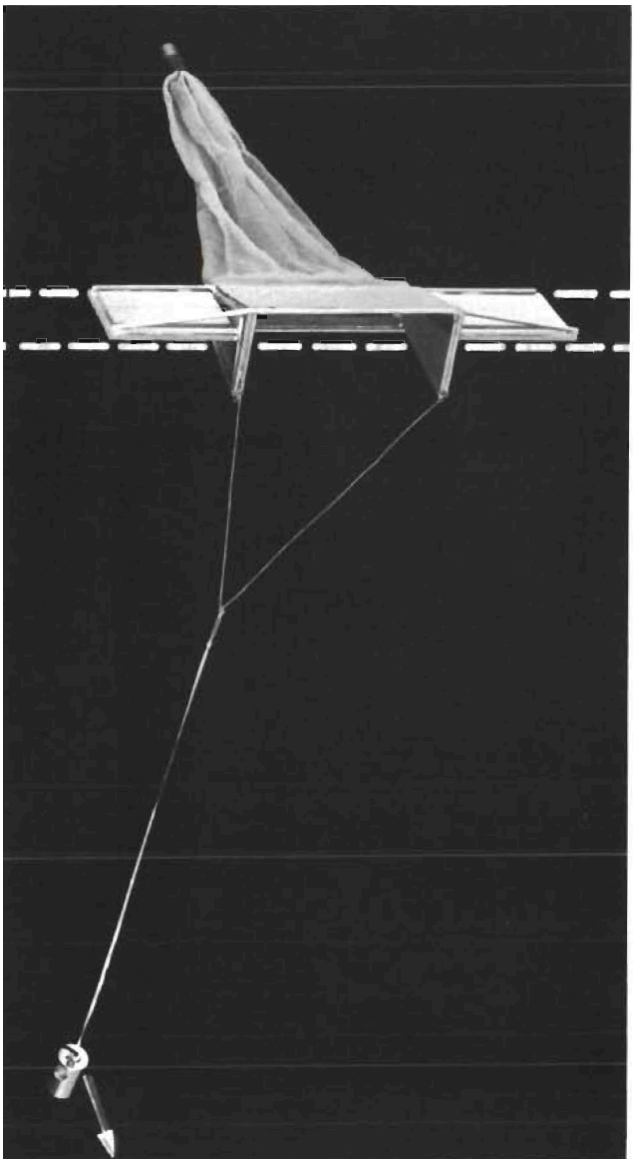


Figure 4 The manta net. Dashed lines show the position of the instrument relative to the sea surface when towed. (Brown & Cheng, 1981)

The construction of the manta net

The students of the Athénée Royal Louis Delattre used as a model the sampling instrument of the European project "DeFishGear" (Figure 3 et 4). In this project, the manta net was built using the design of engineer Marcus Eriksen, founder of the 5 gyres association.

Figure 5 : The manta net used in DeFishGear project www.defishgear.net *photo at left from Andraz lavtizar*

This work was carried out under the supervision of a teacher and with the support of Dr. Andrej Krzan (coordinator of the DeFishGear project) and Dr. Kamel Labibes (Ayam Sailing Europe).

The different phases are presented in the form of illustrative photos with appropriate comments.

This work allows the student to implement the techniques of tracing, cutting, forming and assembly **while respecting safety and hygiene rules and guidelines**.

The student should, amongst others:

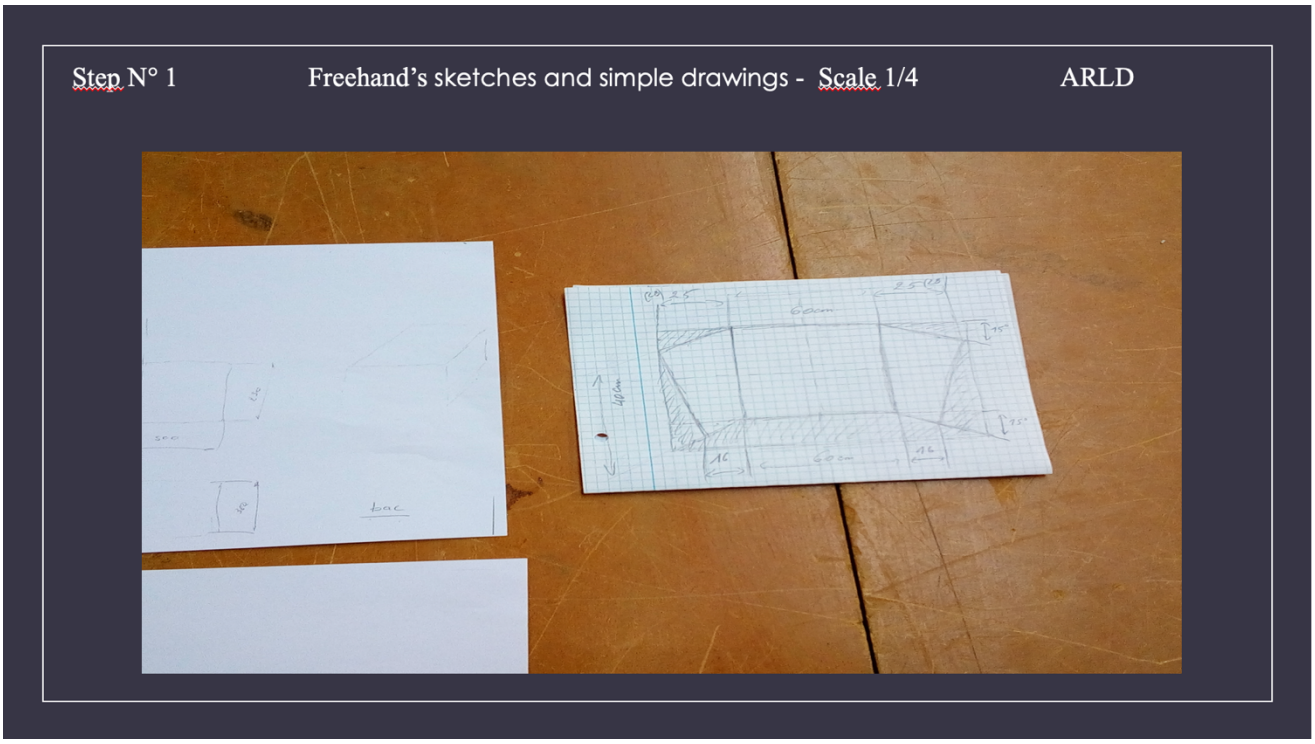
- Use work gloves and protective glasses
- Maintain sufficient space around the work area to avoid accidental contact with passers-by and ensure that there is no risk of slipping or tripping.
- Familiarize himself first with the operations of the machines to be used by checking all procedures and controls.

Technical drawings

The students based their work on the technical drawing of the 5gyres association (in annex).

Make sketches and simple drawings

Prerequisites:
The student must be able to represent the whole in three views while respecting the rules of technical drawing
1 - Make freehand sketches and simple drawings of the frame
Sketching : Simplified but accurate representation of an observation made with a pencil.
Simple drawing: The technical object is represented with a title, scale and captions.
Scale = Dimensions drawn / Actual dimensions



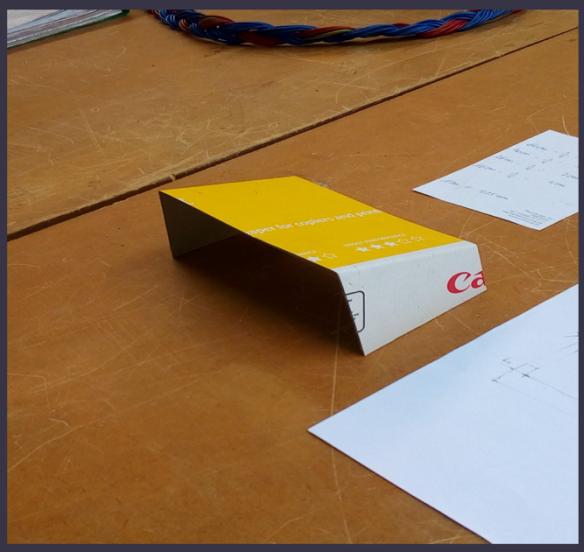
Build a scale model of the frame

It is good practice to make a reduced model in cardboard and then in aluminium with the pupils for before working on a 1/1 scale.
With this phase the student will:

1. understand the procedures and avoid waste;
2. avoid making mistakes;
3. learn to use the necessary tools when building the real model and;
4. get used to working on sheet metal (cutting by shearing, drilling and bending)

Etape 1 ARLD

Frame of the Manta net
in a reduced cardboard model.



Etape N°1 ARLD

Carrying out sheet metal cutting to construct the scaled model.

NB: Gloves and eye protection!!!

Orlowski Kamil 5TEA

Etape N°1

ARLD

Sheet metal cutting

Orlowski Kamil 5TEA

Etape N°1

ARLD

NB: Gloves and eye protection

Sheet metal cutting,
Respect the order of operations.

Orlowski Kamil 5TEA

Etape N°1

ARLD

NB: lunettes et gants de sécurités

Drilling facilitating the cutting of the more delicate parts.

Orlowski Kamil 5TEA

Etape N°1

ARLD

NB: Gloves and eye protection!!!

After cutting, start the folding.

Orlowski Kamil 5TEA

Etape N°1

ARLD

NB: Gloves and eye protection!

After cutting, start the folding.

Orlowski Kamil 5TEA

Etape N°1

ARLD

The scaled model frame of the Trawl Manta.

Realization of the frame at scale 1:1

After the exercise on a scale model, the student is ready to work at 1:1 scale.

Measurement and marking out

The measurement and the marking out are essential steps for a good preparation of the work to be executed.

We call marking out (or layout work) a process by which the lines indicated on a dimensional or plan diagram are transferred to the material on which we are going to work. When marking out, choose a cut that will produce the least amount of metal waste.

A measurement error and a non-accurate marking out lead to a poor execution which will be challenging to catch up (each mistake made adds up at each step). It is crucial to make sure that the correct working techniques are used and that the precision remains a priority.

The student must be able to
- choose the type of marking out equipment to use according to the material.
- Draw the lines within the limits of precision usually tolerated.

In our case, the student uses a steel scale (graduated and relatively flexible steel blade), a flat steel square and a protractor.

Etape N°2

ARLD

measurement and the marking out on an aluminum sheet metal Optimise the the use of the sheet metal as much as possible, beware of waste!

Orlowski Kamil 5TEA

Etape N°2

ARLD

Marking out the 15° angle with the protractor

Orlowski Kamil 5TEA

Cutting using shears

Shearing is a machining process that is used to remove material by cutting without the formation of chips. Cuts may be straight-lined or curve-shaped.

A moving blade comes down across a fixed blade to shear the material.

Shearing produces minimal deformation to the material and is particularly suitable for cutting sheet metal.
Prior to manipulation

- Equipment should be properly supported while cutting and industrial type gloves should be worn to protect hands.
- Identify the cutting location on the workpiece and mark it
- Ensure hands are clear of any pinch points

Operation

1. Insert the sheet metal in the location intended for the cut.
2. Lock the sheet (use locking device)
3. Hold material securely to prevent it from moving during the cut.
4. Lower the lever

Never use the hand shear to cut metal that exceeds the capacity of the machine in terms of thickness, shape, hardness or type.

Inaccessible areas are cut with a jigsaw

Etape N°2

ARLD

Use a jigsaw for inaccessible areas.

Choose the right saw blade !!!

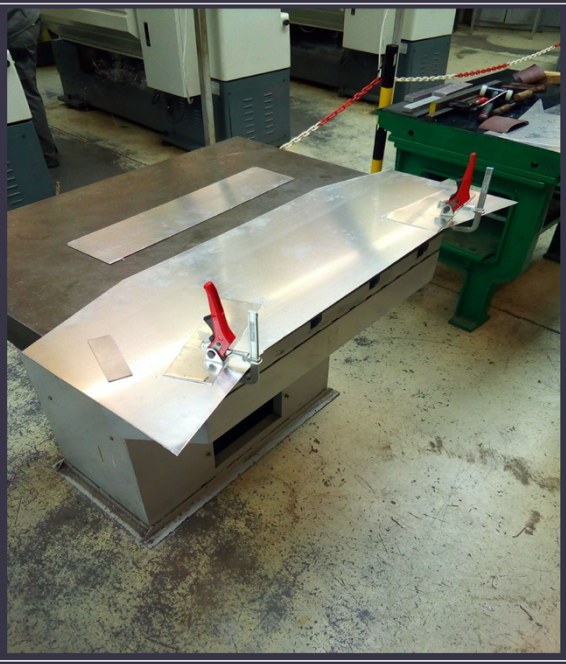
NB: Gloves and eye protection!!!

Orlowski Kamil 5TEA

Etape N°2

ARLD

The cut sheet metal cut before folding

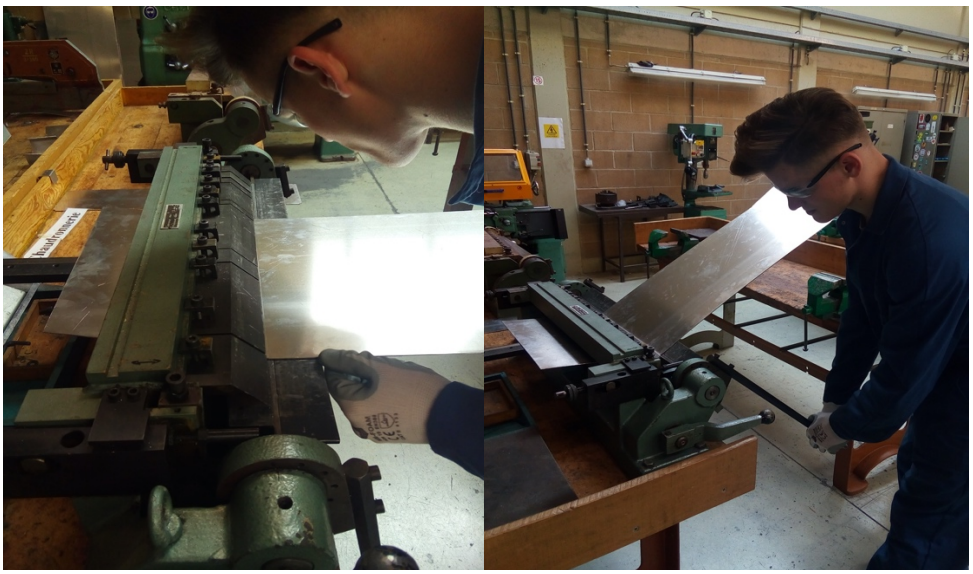


The folding

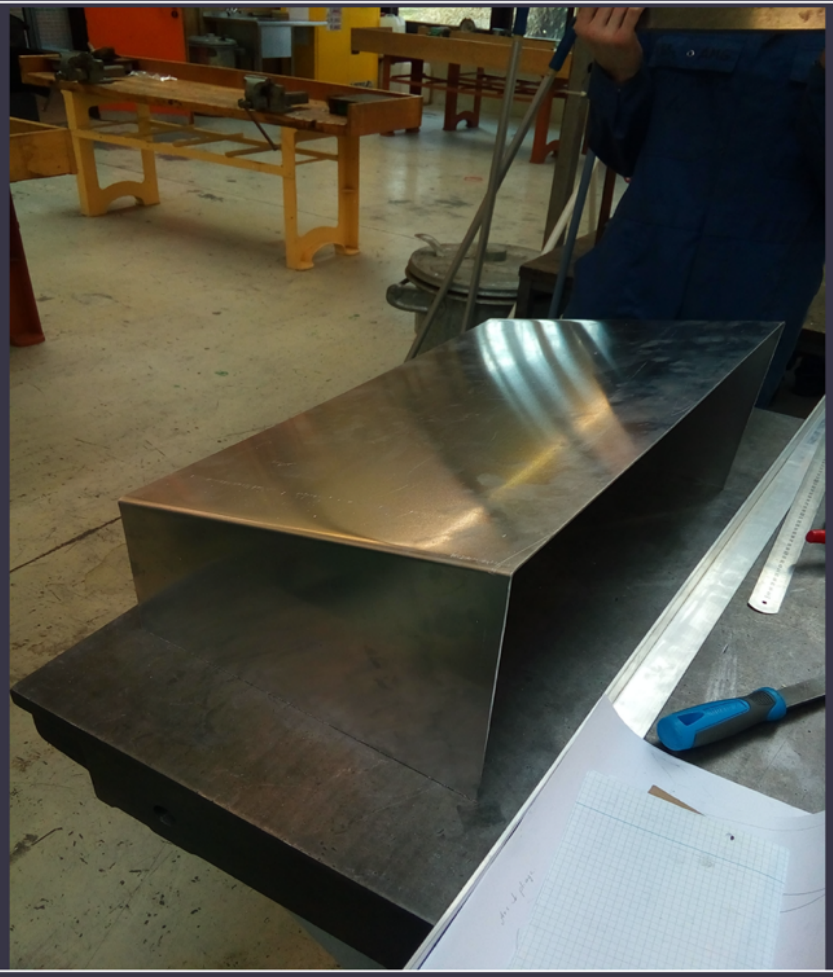
The objective of bending is to provide a three dimensional shape to the sheet metal. Bending or forming is a critical step that can be done by hand or using various tools and machines.

The bending of a sheet is obtained by a localized bending force which changes the orientation of the fibers to obtain a chosen angle. The fibers along the inner bend are compressed, and the fibers on the outside are stretched. Between these two areas is the so called neutral axis where neither the material stretches nor compressed. The resulting angle is called the "bend angle"

We used a manual sheet metal bending machine



Etape N°2



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Assembly by riveting

The net is connected to the manta net frame through a corner profile fixed by riveting.

The rivet is a permanent fastening system made up of two parts: a body with a head (also called a collar) and a nail. It is necessary to drill holes in the elements to be connected.

The rivet should be the same material as the sheet metal to avoid corrosion.
To make a hole in a part, 3 operations are necessary: scribing, pointing and drilling.

- Mark out accurately the respective locations of the holes to be drilled, using a scribe.
- Adjust the rotation speed according to the diameter of the drill.
- Check that the drill is centred on the mark of the needle.

Etape N°2

ARLD

Measurement and placement of the corner which the net will be connected.

Etape N°2

ARLD

Pre-assemby rivets
-gecko type!

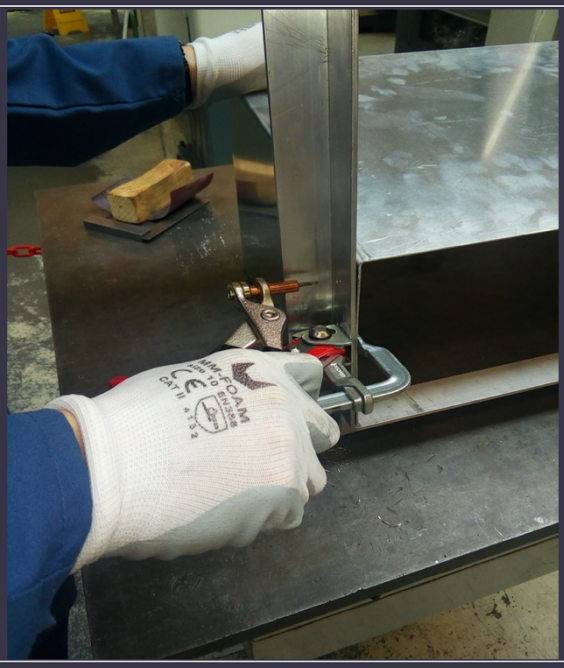
Etape N°2

ARLD

Measurement and placement of the corner profile which the net will be connected.

Etape N°2

ARLD



Pre-assembly

Etape N°2

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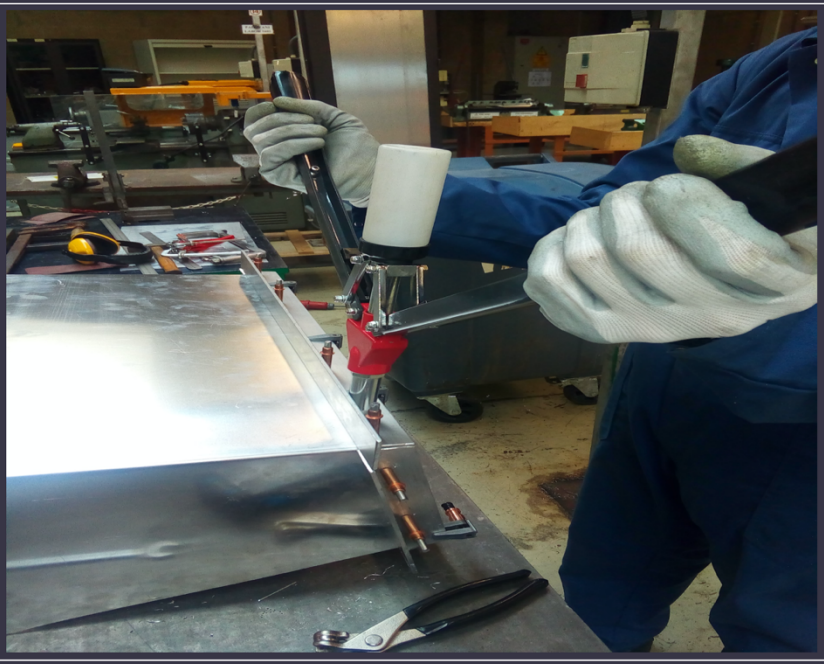

Final riveting

Etape N°2

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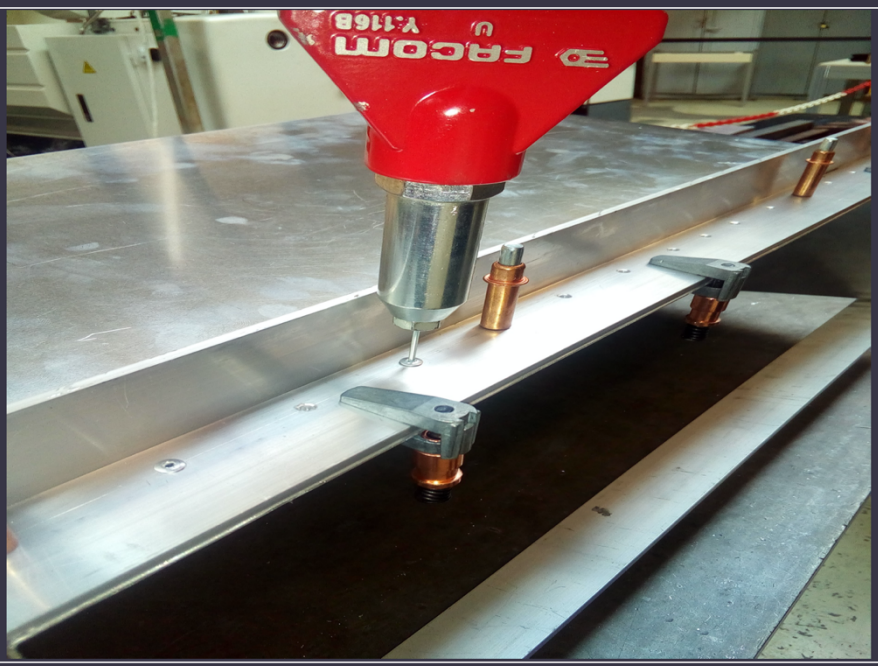
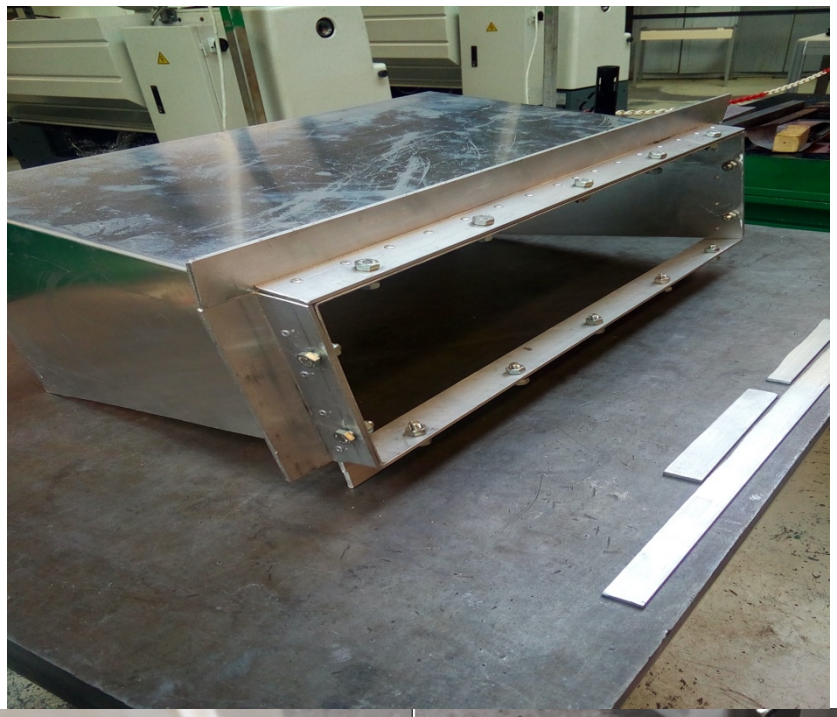
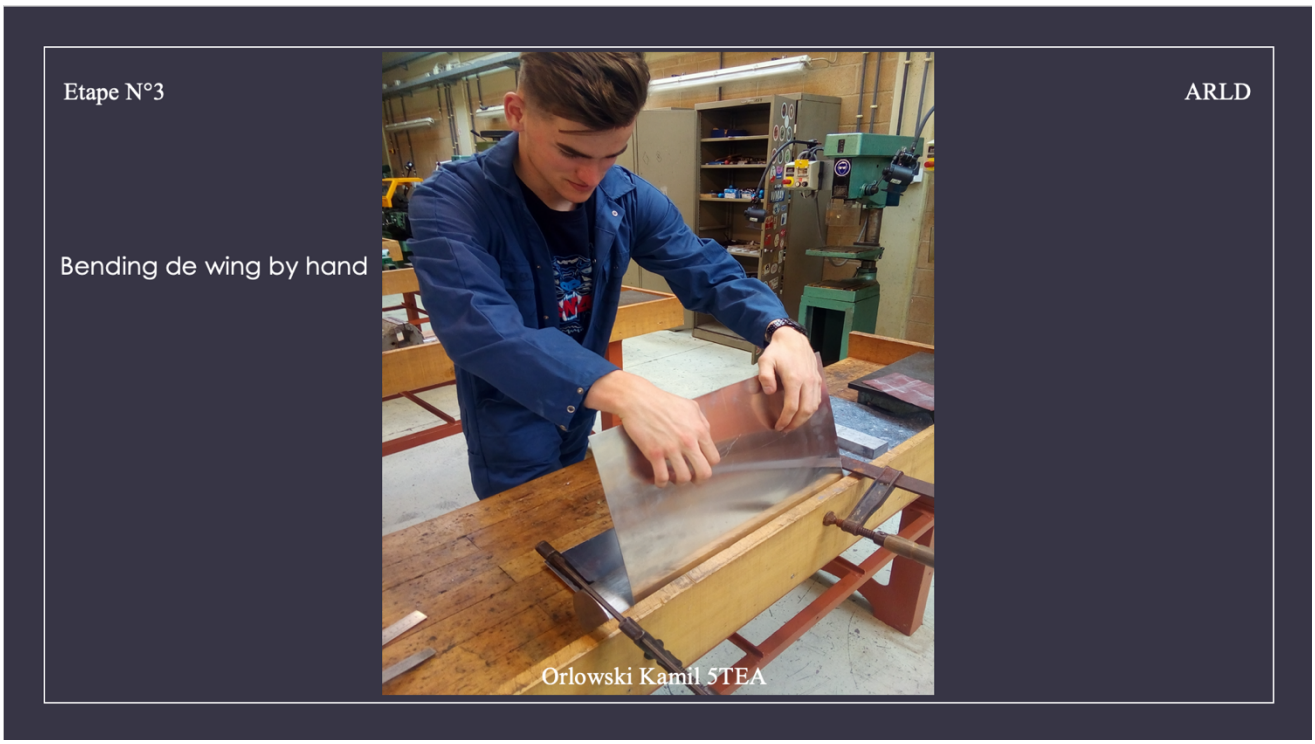


Final riveting



Building the wings of the manta net

The bending of the wing can be done by hand around a cylinder.



Etape N°3

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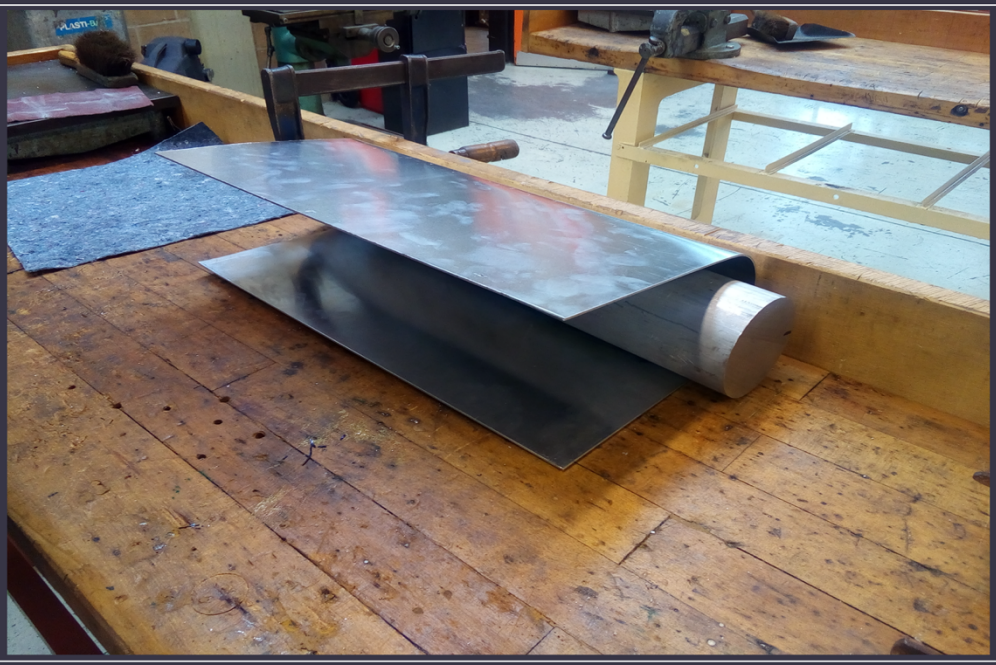
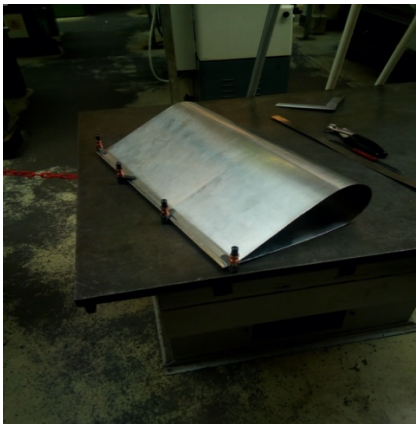
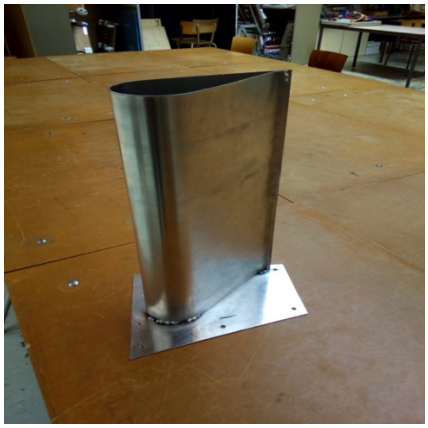
Bending de wing by hand

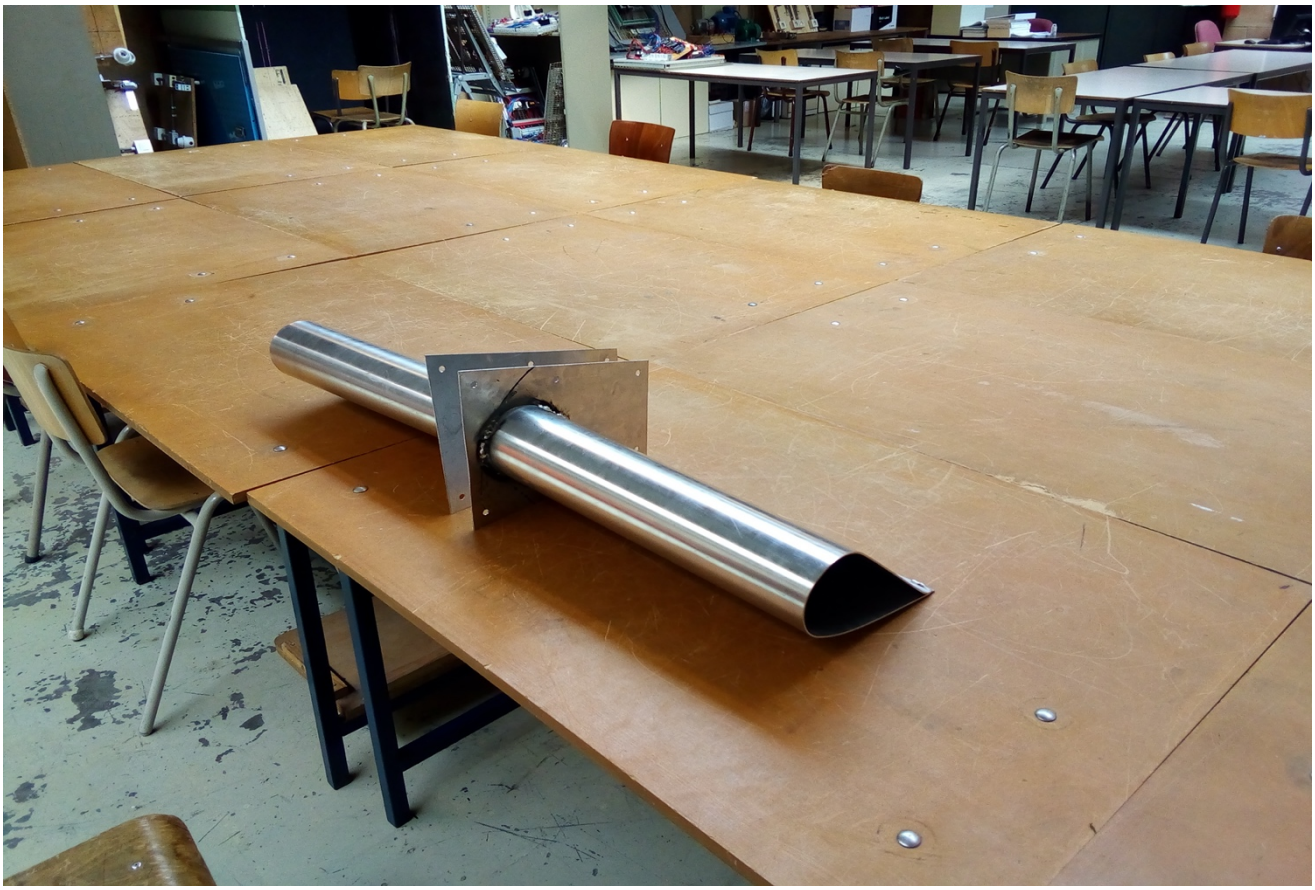
Etape N°3

ARLD







The net can be connected when the wings are welded to the frame.

NB - The validation phase did not take place because it coincided with the health crisis that has crossed Europe.

The building of a manta net is a motivating way for the technical education students to put into practice and acquire competencies relative to the different metal sheet operations as cutting, forming and assembly activities.

Bibliography

Brown, D., & Cheng, L. (1981). New net for sampling the ocean surface. *Ecology-Progress Series, 5*, 225-227.

Annex 1

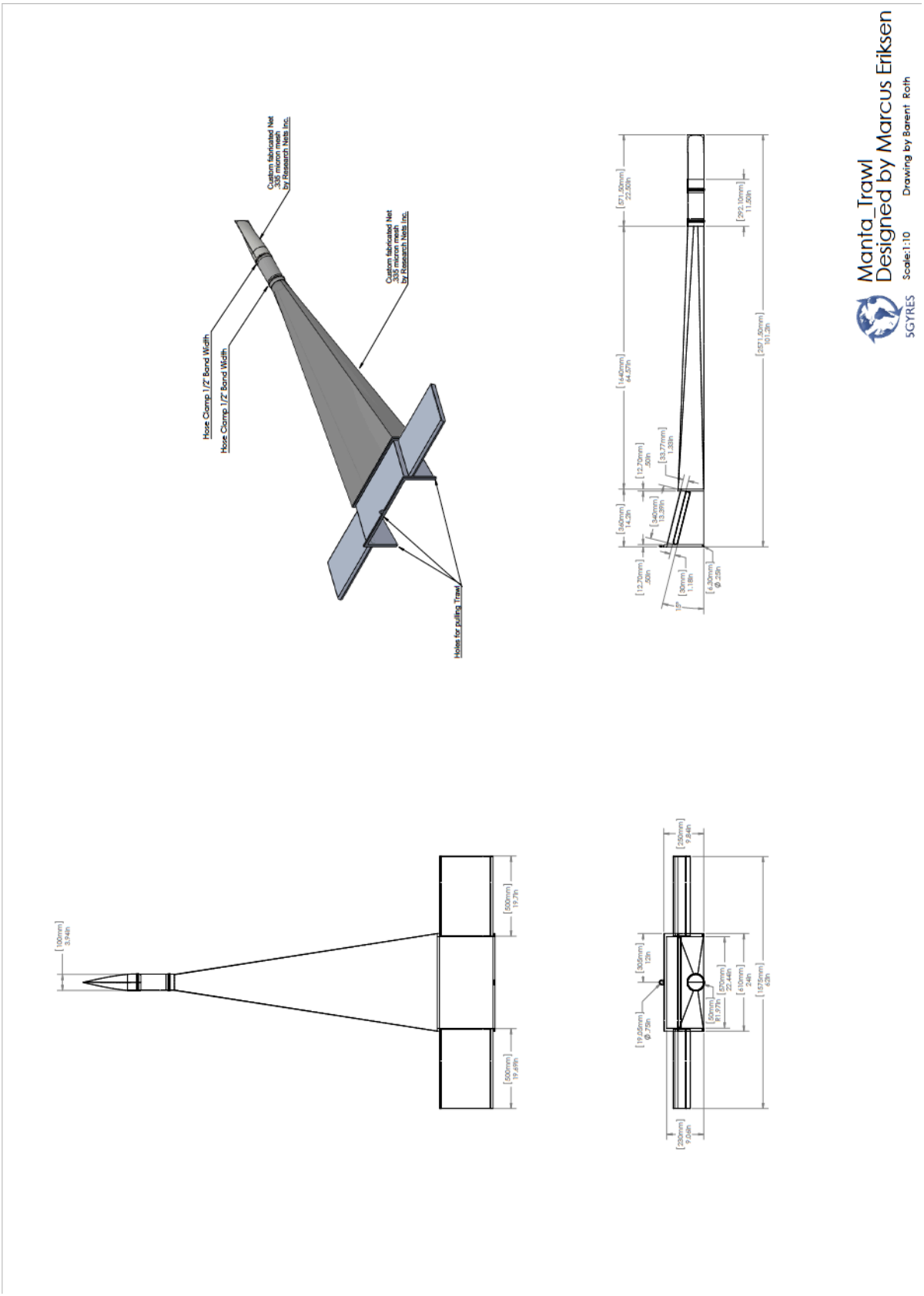


Figure 6Manta net design by Marcus Eriksen (5 gyres association)