DEMETER PROJECT

ROVER MAINTENANCE UNIT

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

UNIT 3

Rover maintenance

Teachers

Alexandre CATALA - Automation teacher, Olivier Couzy, Mathieu Soucasse-CNC Teachers

Students

High school-education, Automation and industrial maintenance formation. 15 - 18 year-old students. Baccalauréat Maintenance of industrial equipments.

Pre-requisites: the students must have many technical skills in automation, electrical engineering, pneumatics, hydraulics, mechanics, machining.

Duration

This Unit consists of four/ five lessons.The students work on this unit for about 4 hours a week for a year and a half.

Objectives and Key competences

Maintenance :

- Be able to read an industrial drawing and locate the parts
- Understand the technology used to assemble the different parts
- Understand and create a Gantt chart to follow the rover production plan step by step
- Carry out maintenance operations to build, machine and assemble the rover

English:

- Acquire the technical vocabulary necessary for the activities

Material / resources

- Internet connection and a computer with Solidworks
- Industrial maintenance workshop

- Tools for making assemblies of parts and measuring

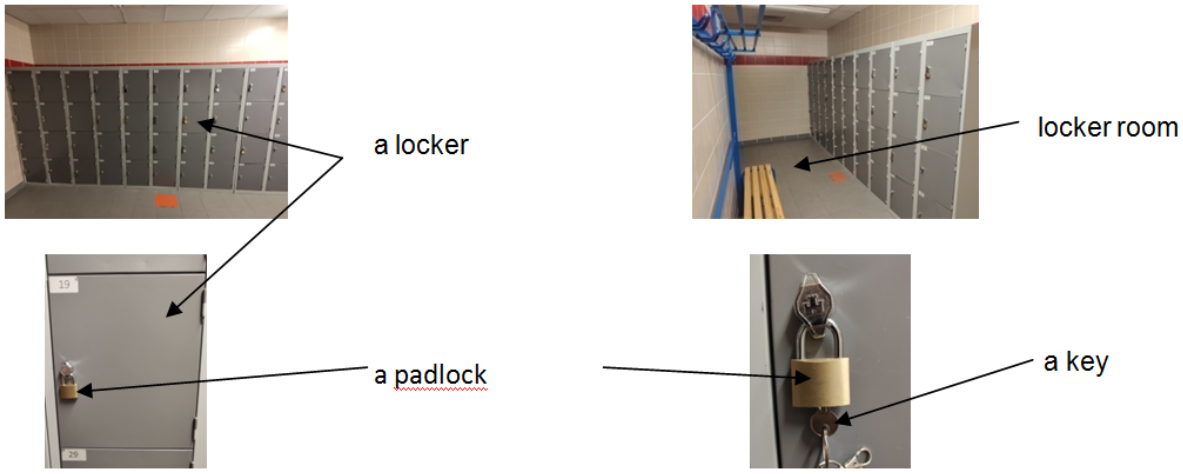
Lesson 1-Workshop tools vocabulary

Students should first learn as much English vocabulary as possible. To begin with the teacher prepares a lesson that will allow students to acquire the names of the main tools in English in order to be able to collaborate easily with other partners.

Tools in a maintenance workshop

Looker room

1- Look at the words in the list and place them in front of the correct picture
List: looker room - a looker - a padlock - a key



2- Complete the sentences with the words from the previous activity

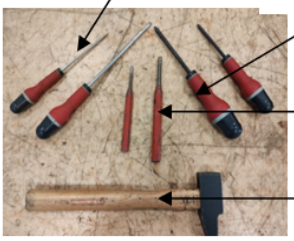
Before and after the vocational courses I have to change my clothes in .....

Inside my ..... I can store my things

To prevent someone from stealing my stuff I lock the door with a .....and I unlock it with my own .....

3- Learn the vocabulary of the tools then give the correct answer when the teacher shows the tool to the

Toolbox

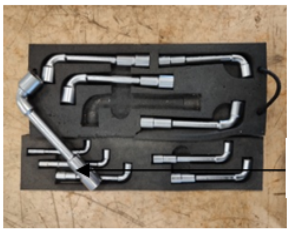


Flat screwdriver

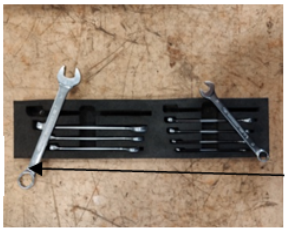
Cross headed screwdriver

a pin remover

Hammer



Angled socket spanner

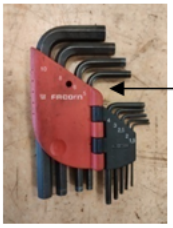


Combination wrench

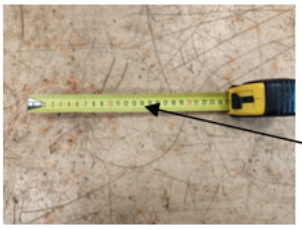
multigrip pliers

a chisel

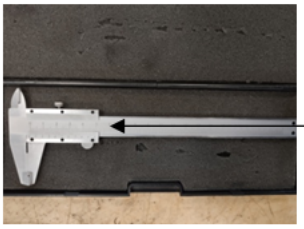
cutting pliers



Hex wrench



a tape measure



caliper

multifonction universal pliers

Lesson 2- Understanding the rover parts

During this lesson the students are going to read and analyse the 3D drawing of the rover.

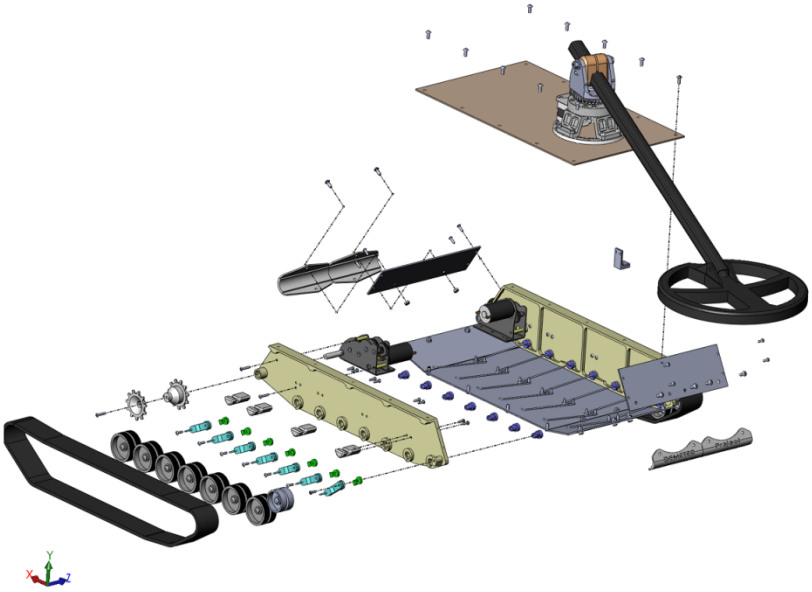
The main objective of this activity is for the students to able to know the parts to be assembled but also to choose the appropriate tools.

The teacher gives the students the 3D drawing of the rover on a sheet of paper as well as the Solidworks files allowing them to find the shape and size of the parts with precision.

The teacher asks the students which tool they should use to carry out the various dismantling operations.

Only a few questions are mentioned below. Many exercises have been done in this lesson, here is just an example :

Drawing of the disassembled rover

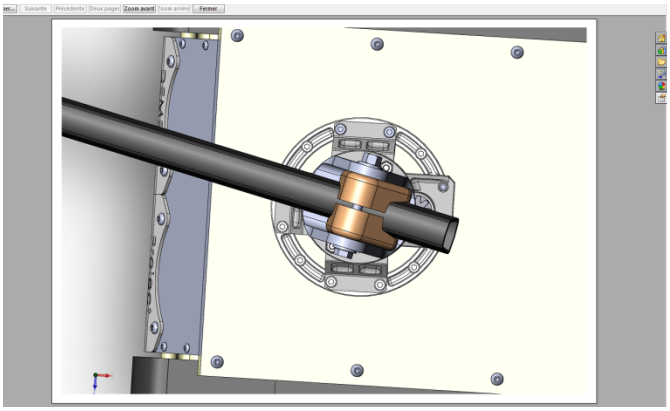


Question N°1: On the drawing above circle the gearboxes of the rover

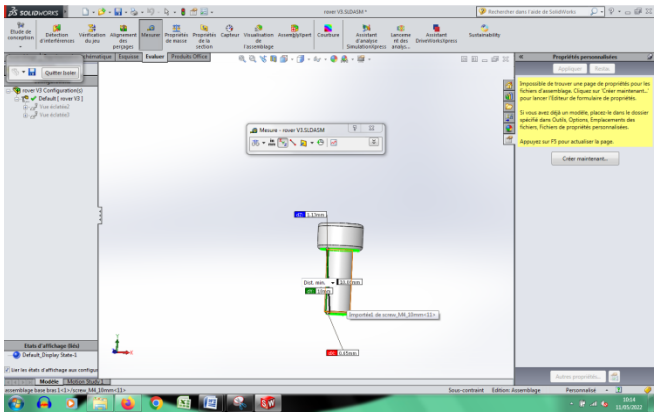
Question N°2: How many screws must be unscrewed to disassemble the upper plate of the electronic arm support ?

……

Question N°3: On the diagram below, color in red the screws used to assemble the arm of the detector to the upper plate of the rover



Question N°4: Indicate on the drawing below the measurements to be taken in order to know the characteristics of the screw. (screw head diameter, screw diameter and length, tool footprint size). For this you have to use Solidworks with the measurement function.



Screw head diameter:.....mm

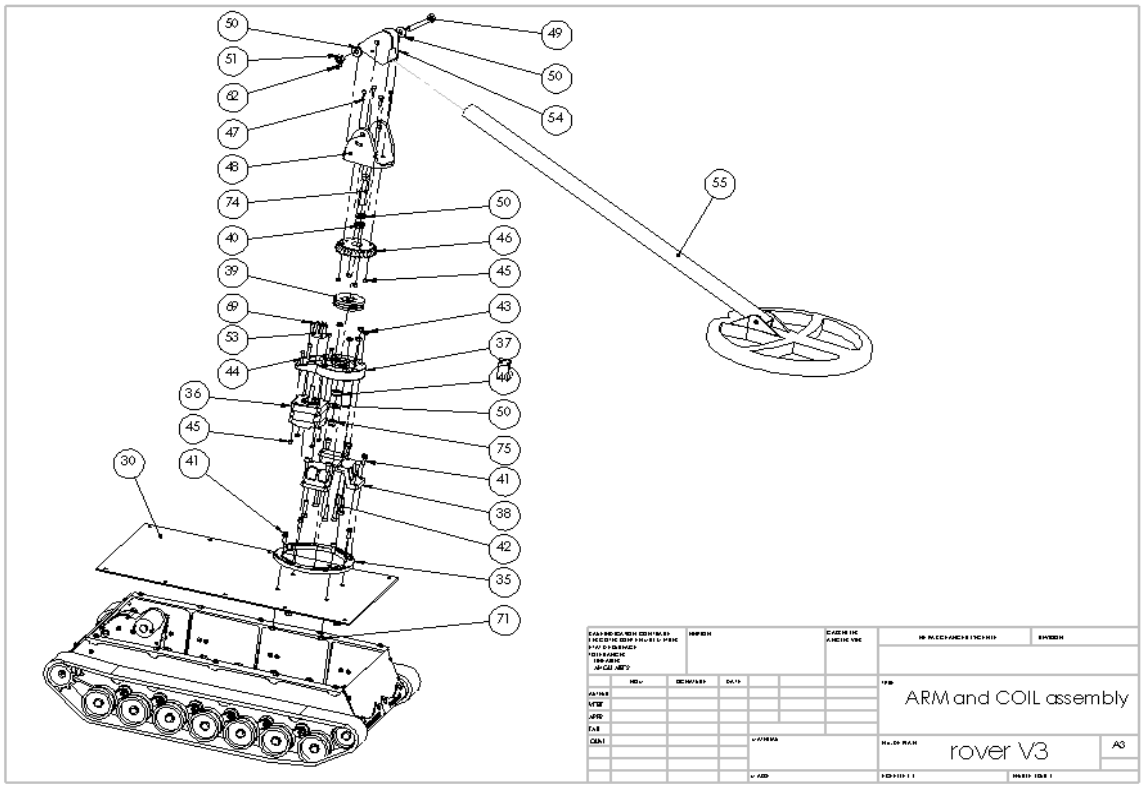
Rod screw diameter:.....mm

Screw length:.....mm

Tool footprint size:.....mm

Question N°5: Dismantling procedure

Using the 3D exploded view of the rover, the students must complete a procedure for assembling the arm of the rover.



Rover Arm Mounting Procedure

Stage	Tasks to be done	Parts	Cautions
1	Insert the 6 nuts 43 inside part 37	43, 47	correctly positioned the nuts
2	Position the 3 feet of the arm 38 then insert and tighten the 6 screws 42 inside the nuts 43	38, 42, 43	Do not apply a large tightening torque to avoid damaging the feet of the arm 38
3			
4			
5			
6			
7			
8			
9			

Lesson 3-Instroduction to the Gantt diagram

This lesson is an introduction that will allow students to understand what the diagram is and how to use it to improve the management of the project. This tool will be used by the students to plan the different stages of the manufacture of the chassis.

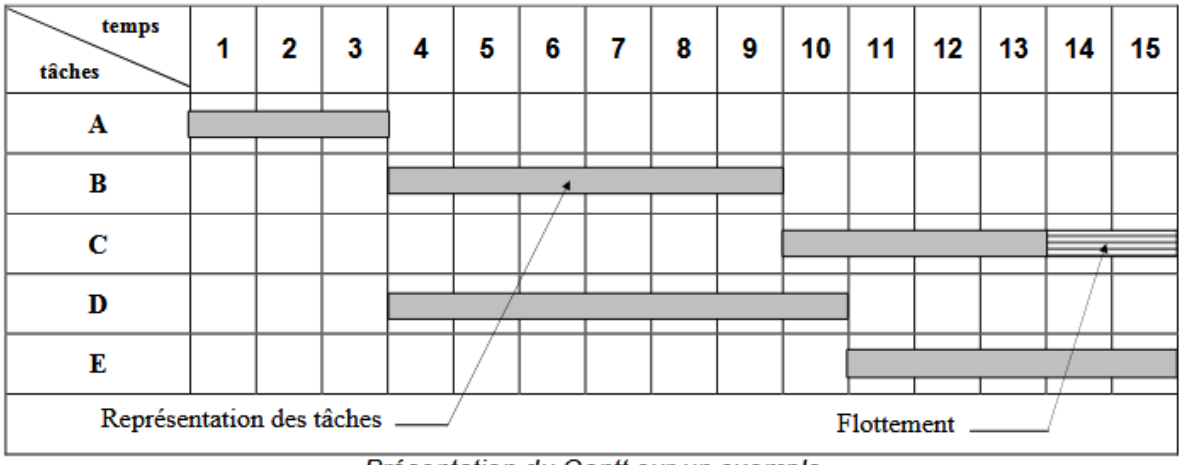
LES METHODES DE GESTION DE PROJET

Liens entre les opérations :

- B et D après A ;
- C après B ;
- E après D

Le diagramme de Gantt se présente sous la forme d'un tableau quadrillé où chaque colonne correspond à une unité de temps et chaque ligne à une opération à réaliser.

On définit une barre horizontale pour chaque tâche ; la longueur de celle-ci correspond à la durée de la tâche. La situation de la barre sur le graphique est fonction des liens entre les différentes tâches.



Présentation du Gantt sur un exemple

♦ **Critère de représentation classique du Gantt**

On commence le plus tôt possible les tâches qui n'ont pas de tâches antérieures.

Lesson 4-Create and use the Gantt chart

The students with the help of the teacher must create a gantt chart which must contain the tasks to be carried out for the construction and assembly of the Demeter rover.

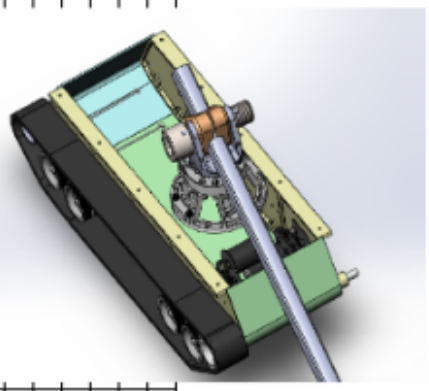
PLANNING DEMETER PROJET ERASMUS 2019-2022	janv.-22	févr.-22	mars-22	avr.-22	mai-22	juin-22	juil.-22	août-22	sept.-22	oct.-22	nov.-22	déc.-22
# DRIVE TRAIN CHASSIS					MEETING IN CROATIA					Multiplier event in Brussel		
Design wheel support												
Wheel support machining (5 units R & 5units L)												
Wheel support trace drill and tap												
Design track supports												
Track support printing (30 units)												
Design hull/ collaboration Mr Pugnet												
Hull production/adjusting bottom & top (5 units each)												
Design bearing shell												
Bearing shell machining (70 units)												
Torsion bar fabrication (70 units)												
Design internal plate												
Build internal plate for components (5 units)												
Design Square for internal plate												
Print Square for internal plate (30 units)												
Rover assembling												
Rover kit creation (boxing)												
Rover assembly documents												
Drill and tap plates bottom & top												
Print chassis arm parts (5 units)												
demoulding square ant track support												
make a inventory of detector arm												
send the plans of rover to Art teacher												
drill and install the front and back plates												
Print bumpers for the front and back												
#INTEGRATIONCHASSISARMELECTRONICS												
technical design of arm on chassis												
electric actuator												
electronic integration chassis												
Parts production (CNC, 3d printer…)												

Participants	# DRIVE TRAIN CHASSIS Alexandre CATALA Damien Barbe Patrice Suin	#INTEGRATIONCHASSISARMELECTRONICS David pugnet Alexandre CATALA	
Rep	1	2	3

Activity done

Start activity

Dead line



The main objective of this lesson is that the students will acquire skills that will enable them to manage industrial projects.

Lesson 5-Rover production plan

To carry out the activities presented is this lesson, it's important to stress out that the students must previously have done the activities in "Unit 1 : how the rover move" and

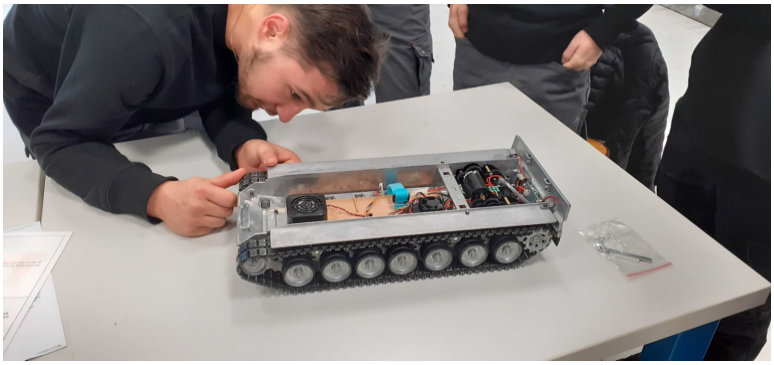
"Unit 4 : Rover part fabrication".

In this lesson, the students are going to study the technological part of the rover that will allow them to assemble and make the necessary settings according to the Gantt diagram previously defined.

The leaders of the chassis creation process is the French team.

One of the objectives of the DEMETER project is the creation of a Mine detection Rover. The following short presentation outlines the design of the Rover´s chassis, in order to produce a chassis that corresponds to the needs of a dedicated all-terrain mine detection vehicle.

- The first steps we took was to study a commercially available chassis model of a Leopard II from the Torro brand, which are very robust vehicles that function adequately on all types of terrain. The commercially available chassis became our development test model.



students analyze the chassis

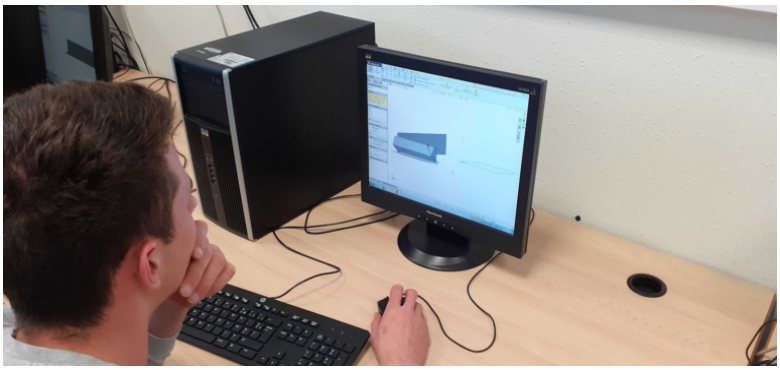
- First we chose to create an aluminium frame by a plate folding and adjustment technique. Regarding the fixing points for the side wheels, we have decided to carry them out using CNC machining.

- One of the most complex parts of designing and machining is the suspension, which is based on torsion bars. The design and machining of the suspension system required all the expertise and knowledge of both teachers and students

Wheels and suspensions

Torsion bar and bearing shell

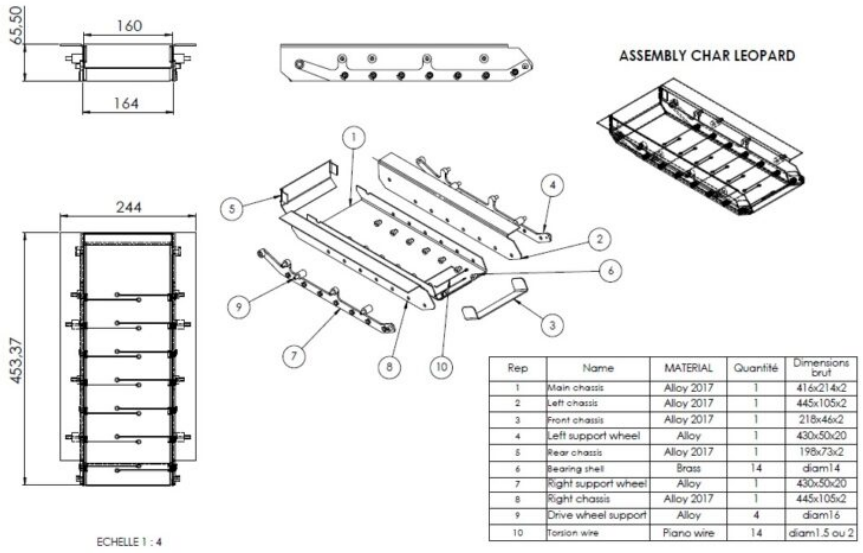
- The students participated very actively in the process and it helped them to put into practice all the CAD (Solidworks 3D) knowledge learned so far in a real project. During this phase the collaboration with the teachers is very active.



The students design the chassis with Solidworks

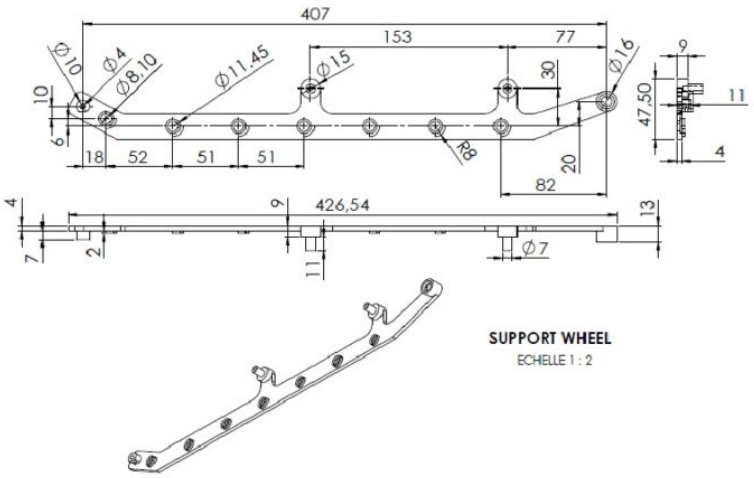
- First we chose to create an aluminum frame by a plate folding and adjustment technique. Regarding the fixing points for the side wheels, we have decided to carry them out using CNC machining.

This professional training is also present in our high school.



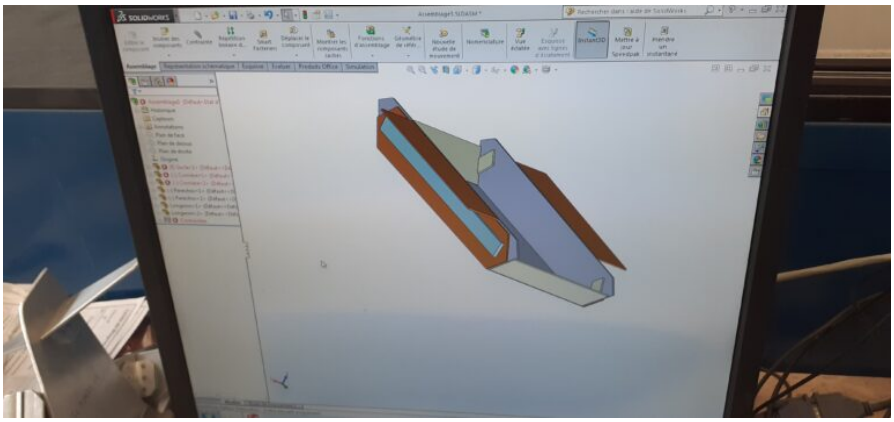
Rep	Name	MATERIAL	Quantité	Dimensions brut
1	Main chassis	Alloy 2017	1	416x214x2
2	Left chassis	Alloy 2017	1	445x105x2
3	Front chassis	Alloy 2017	1	218x46x2
4	Left support wheel	Alloy	1	430x50x20
5	Rear chassis	Alloy 2017	1	198x73x2
6	Bearing shell	Brass	14	diam14
7	Right support wheel	Alloy	1	430x50x20
8	Right chassis	Alloy 2017	1	445x105x2
9	Drive wheel support	Alloy	4	diam16
10	Torsion wire	Piano wire	14	diam1.5 ou 2

First chassis CAD model of the Rover V1

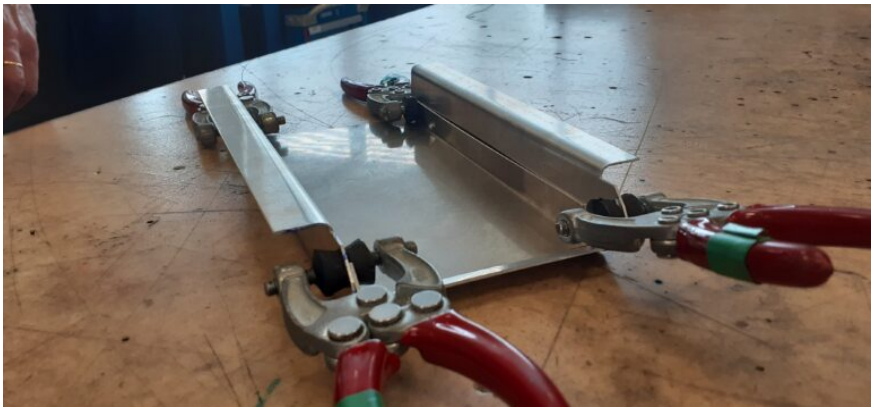


First chassis CAD model of the Rover V1 with measurements

- When the 3D model was finished we started manufacturing the chassis by bending sheet metal. Damien Barbe aeronautical structure teacher , guided his students until the realization of the first frame. Numerous skills were acquired: **drawing reading, cutting sheets, plotting, machining, bending and adjusting the sheets together.**



3D rover V1 model on the screen



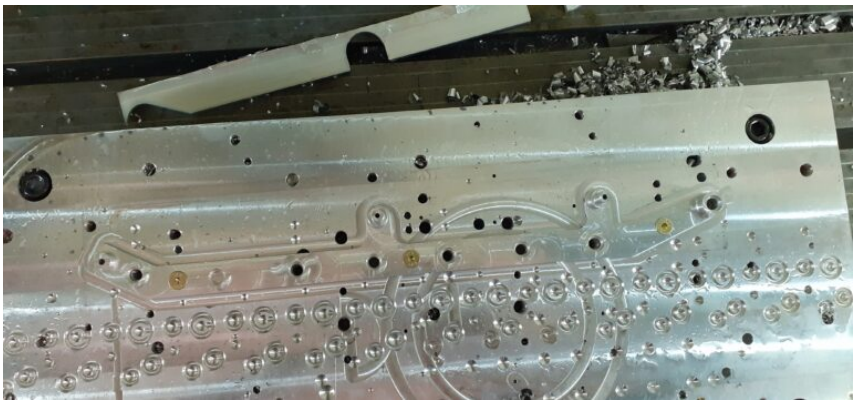
Adjusting the chassis aluminum plates after cutting and folding

- At the same time, we asked for highly motivated machining teachers to work on the project. Olivier Couzy, Mathieu Soucasse and Laurent Massoulard (CNC teachers) worked with their students on the programs as well as the machining of the rover's wheel supports.

Click on a blue link below to see the wheel support machining videos

https://www.youtube.com/watch?v=fyzXL5aG3qU

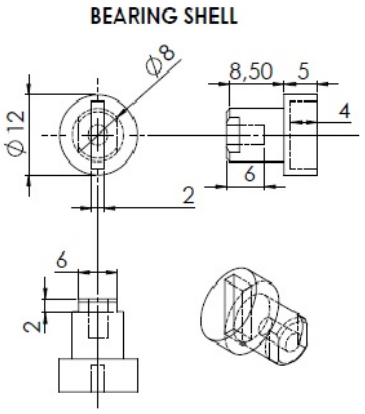
https://www.youtube.com/watch?v=Yv2LIJmB1pU



First wheel support before demoulding

Final result ready to be assembled

- To allow assembly and guidance of the wheels to the torsion bars, we also had to draw the 3D model and machine the bearing shells. This complex part was machined with a CNC turning and milling machine. The students were able to acquire many skills in machining.



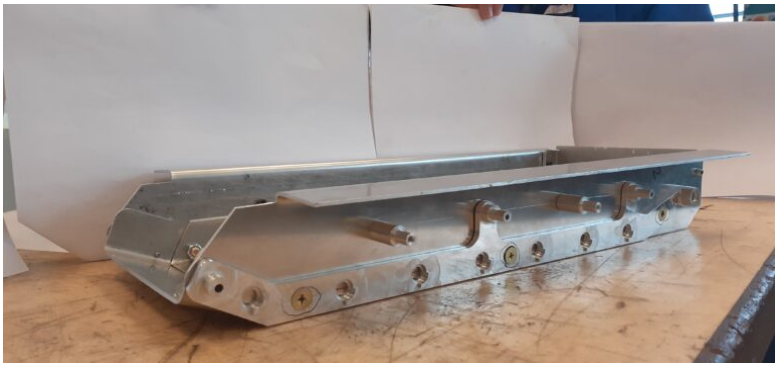
Bearing shell 3D model

Click on a blue link below to see the bearing shell machining video

https://www.youtube.com/watch?v=TuH4XeR18dw

- Industrial maintenance students tap the bearing shells with the tap bit of M 3 mm.

- The automation students adjust the wheel support on the chassis. Numerous skills were acquired: **plotting, drilling, tapping and fitting**.



Wheel support on the rover chassis V1

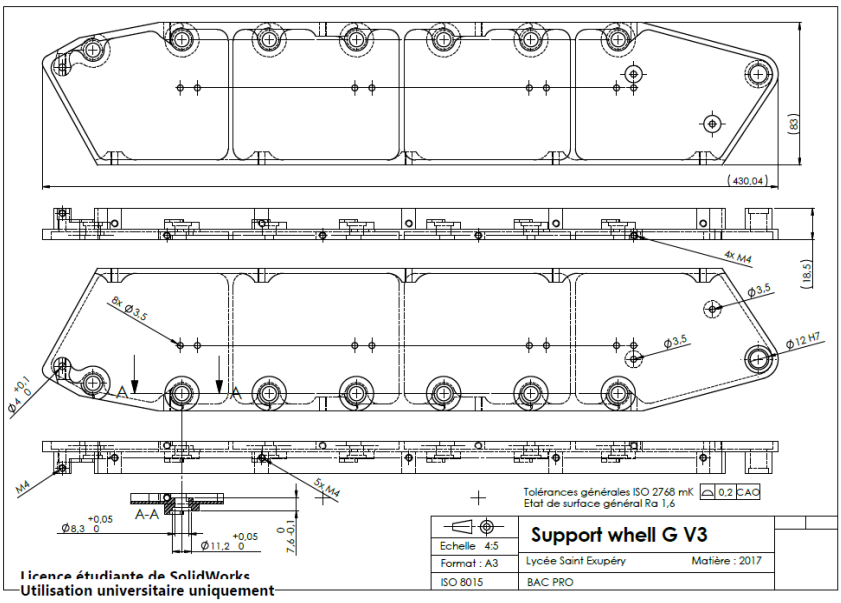
Click on a blue link below to see the wheel support adjusting on the chassis video:

https://www.youtube.com/watch?v=ooRzO3kI3xA

SOLVING A TECHNICAL PROBLEM WITH OUR DESIGN

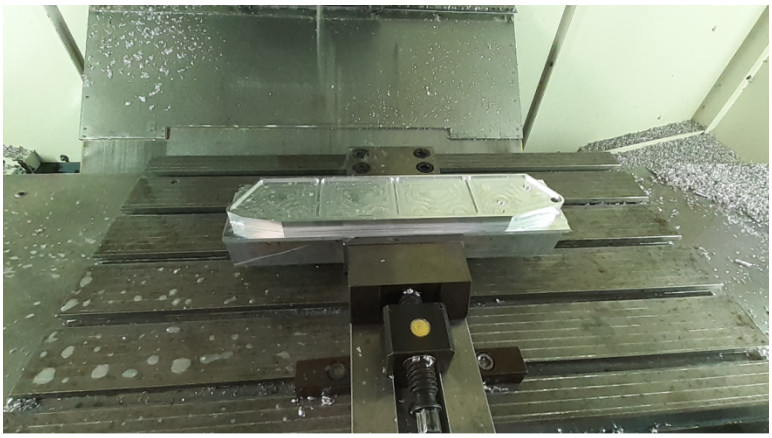
After examination, the assembly of the support wheel on the chassis was not compliant with the expected result. In fact, we saw that the rigidity of the chassis was very poor. This was probably due to the fact that the chassis is composed of seven different parts screwed together. Cf: *First chassis CAD model of the Rover*

To solve this very important problem and get the best result, we decide to make and new 3D model and to simplify it. To do that, we decide to integrate the wheel supports into each side of the chassis. We think that thanks to this modification, the rover rigidity should be better.



Wheel support 3D model after modifications with measurements

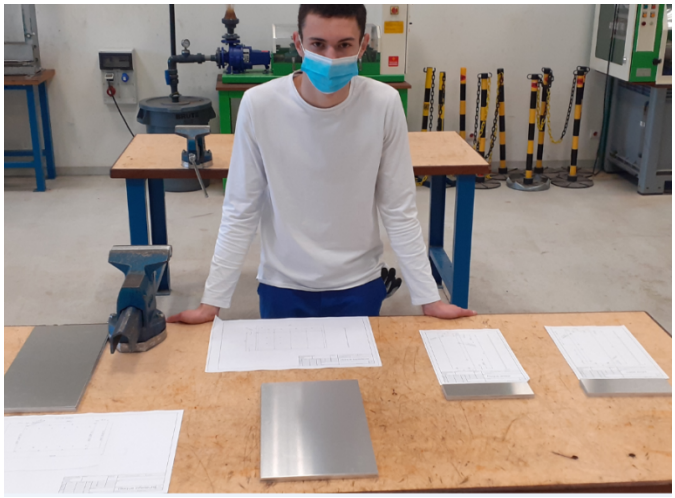
- We Machine new whell supports in CNC workshop with the new CAD model.



New whell supports in CNC machine just after machining.

Whell supports left and right after machining for five rovers V2

- The automation students build and cut the aluminum plates to link the wheel supports together.



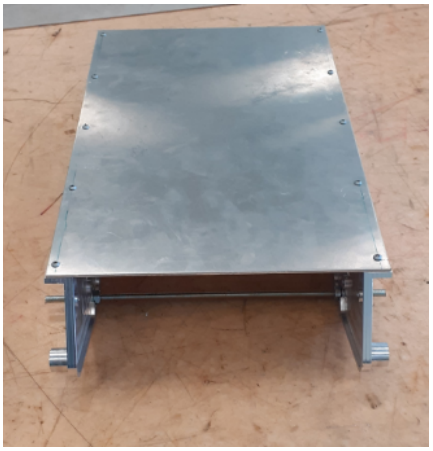
Different aluminum plates for the rover V2 before folding and drilling

- The teachers organize the production plan in order to involve as many students as possible. We have to build five rovers.

Some teachers and students before working on the V2 rover in the workshop at the lycee saint exupery high school in Blagnac.

- The second generation of the rover has been simplified. The students must carry out the bending as well as the adjustment of the aluminum plates.





wheel support positioning using threaded rod and nut,

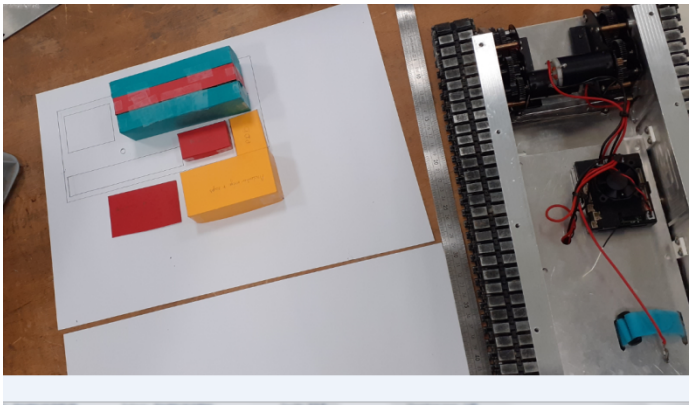
and clamps to adjust aluminum plates on wheel supports

SOLVING A TECHNICAL PROBLEM WITH OUR DESIGN

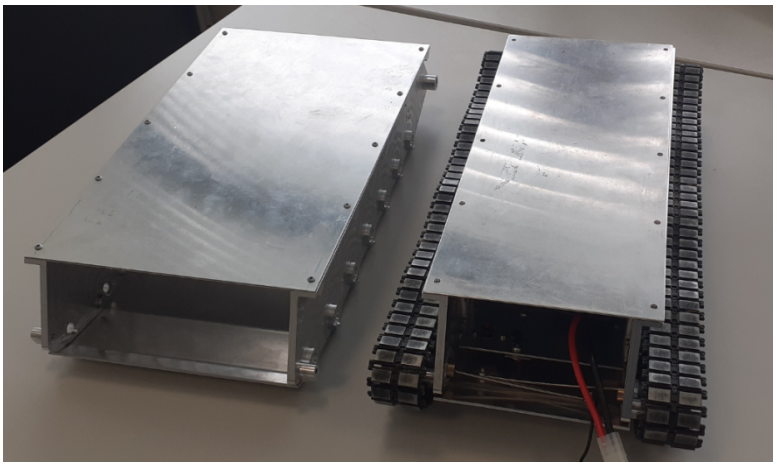
Working in collaboration with the Spanish partner,that is teachers from Estepona high school, we could easily see that the internal part of the rover was too small. Indeed this part is intended for the placement of the electronic components for the arms of the detector.

We therefore decided to design and build a new rover which would be wider, so as to integrate all electronic components.

- The students make cardboard boxes with the same dimensions as the electronic components in order to define the new dimensions of the internal part of the V3 rover. After this study we decide to increase the width of the V3 rover by 65 mm compared to the V2 rover.



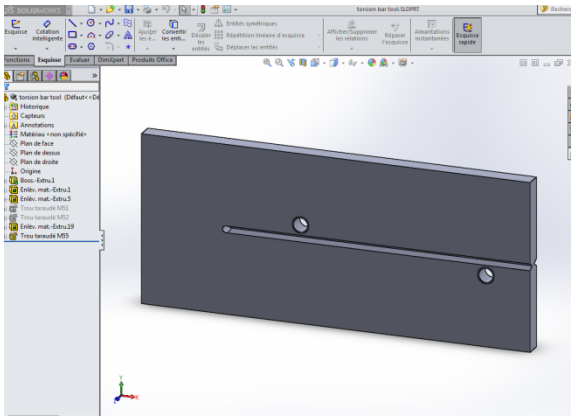
Cardboard contruction to define the rover internal part

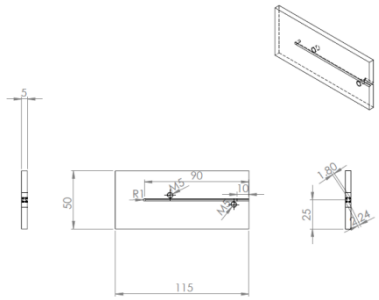


Here is the V3 rover on the left 65 mm wider to integrate

all the electronic components correctly compared to V2 rover on the right

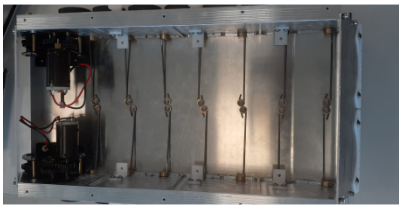
To build five V3 rover we have to make the torsion bars for the suspension. As we have to make 70 of them, we decided to make a crafting tool to obtain the same dimensional characteristics.





- The students design with Solidworks and build a torsion bar tool to make the torsion bars for each V3 rover.

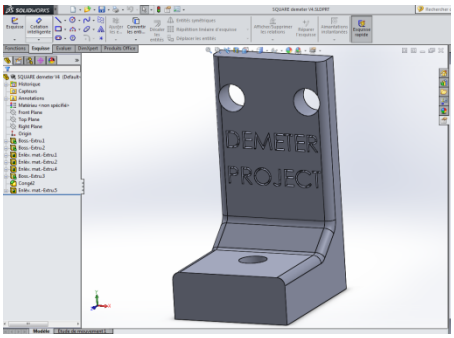
- Students assemble the different parts of the suspension and the engine



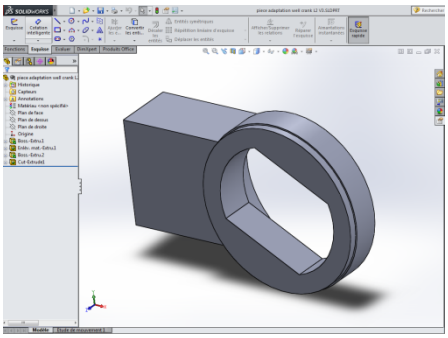
Assembly of torsion bars for suspensions as well as gearboxes and engines.

To simplify our manufacturing process and involve the students as much as possible, the teachers decided to create the missing parts on Solidworks and print them with a 3D printer.

- The students design specific missing parts for the V3 Rover.

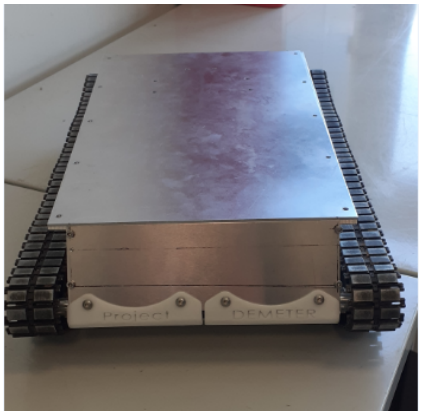


internal plate support



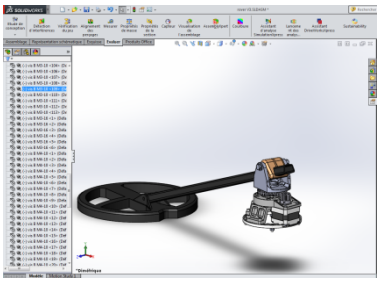
suspension adapter

- The students assemble all components on the chassis.



First V3 rover finished to be assembled

- Using 3D drawings and 3D printing, and the work done in lesson 2 is this unit, students assemble the arm of the V3 Rover which will drive the detector coil



- The students assemble the arm on the top of the V3 rover.

First V3 rover with arm for detection

- The teachers and students test the first V3 rover in the automation workshop at the lycée saint Exupéry high school in Blagnac.

Click on a blue link below to see the first V3 rover test video:

https://www.youtube.com/shorts/rsvdCkxg5MU

Results and outputs

●The students were able to produce quality work, using skills and knowledge they had previously.

●They also improved their knowledge on the technical activities, to better understand the ins and outs of landmines. In some activities we have even exceeded the results we expected to obtain.

●This unit allowed them to seriously follow an industrial production plan from start to finish of rover manufacturing. This skill will be appreciated by their future employers.

●This unit inspired and motivated some of them to work at home or at school outside of their schedule .

●This unit allowed the students to improve their english.

Teachers' evaluation of the lessons

●Drive train chassis has been a truly rewarding unit. It allowed students to make a lot of progress but above all to motivate them even during the Coronavirus pandemic.