

BIANCIOTTO Tom
CLAVEL Maxime
GASTON Louis
LEGARDEUR William
LENNE Margaux
WILLIE Nsongurua Innocent



École nationale supérieure de génie industriel

OPEN SOURCE PLASTIC RECYCLING MACHINE

Mardi 24 mai - Jalon L4





PLAN

I - Context of the study

II - Specifications

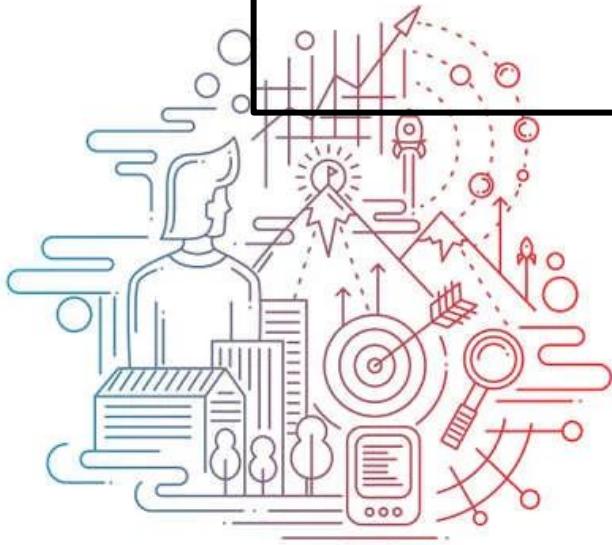
III - Technical and scientific work

IV - Solution and Verification of the specifications

V - Project management

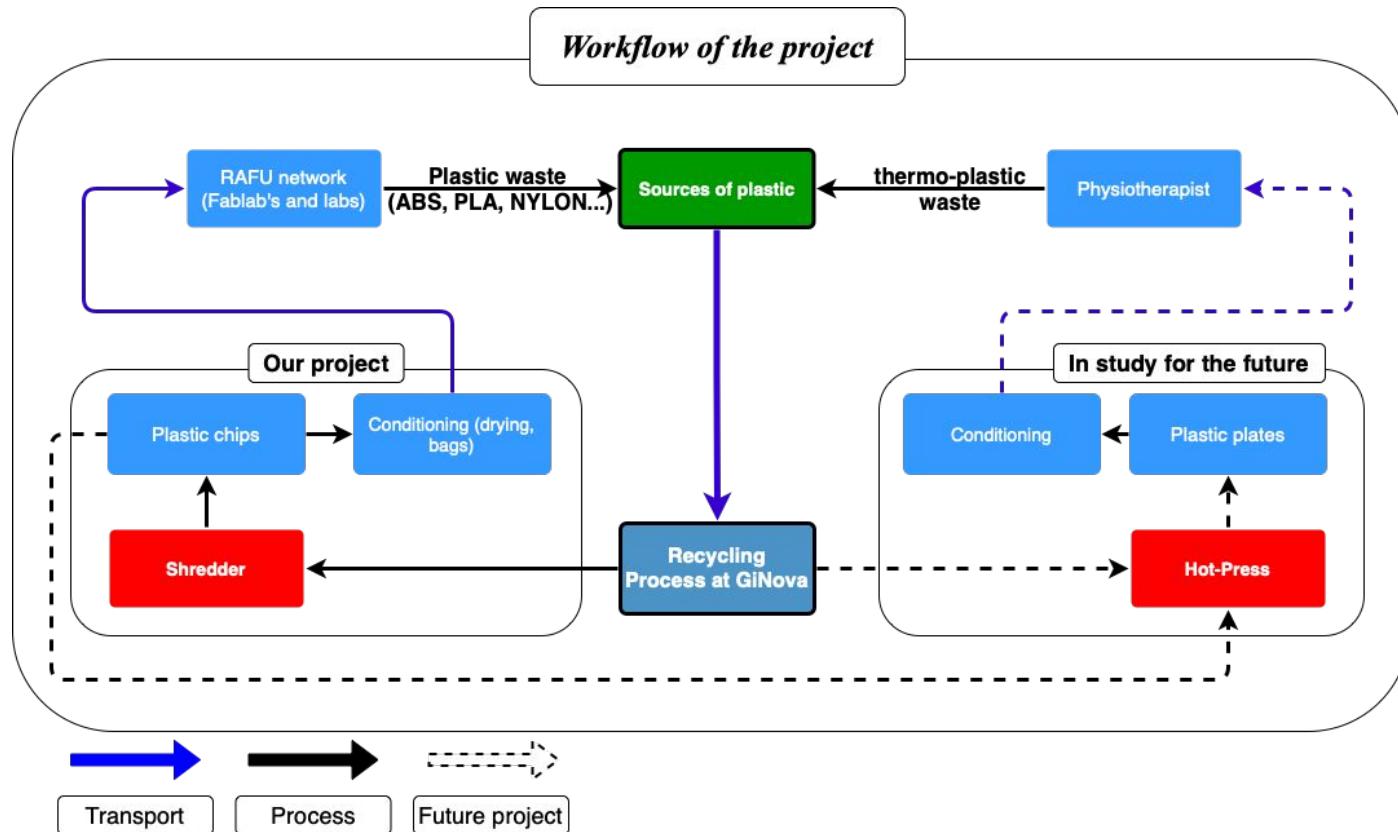
VI - For next years

I - CONTEXT OF THE STUDY



I - CONTEXT OF THE STUDY

fab
MSTIC



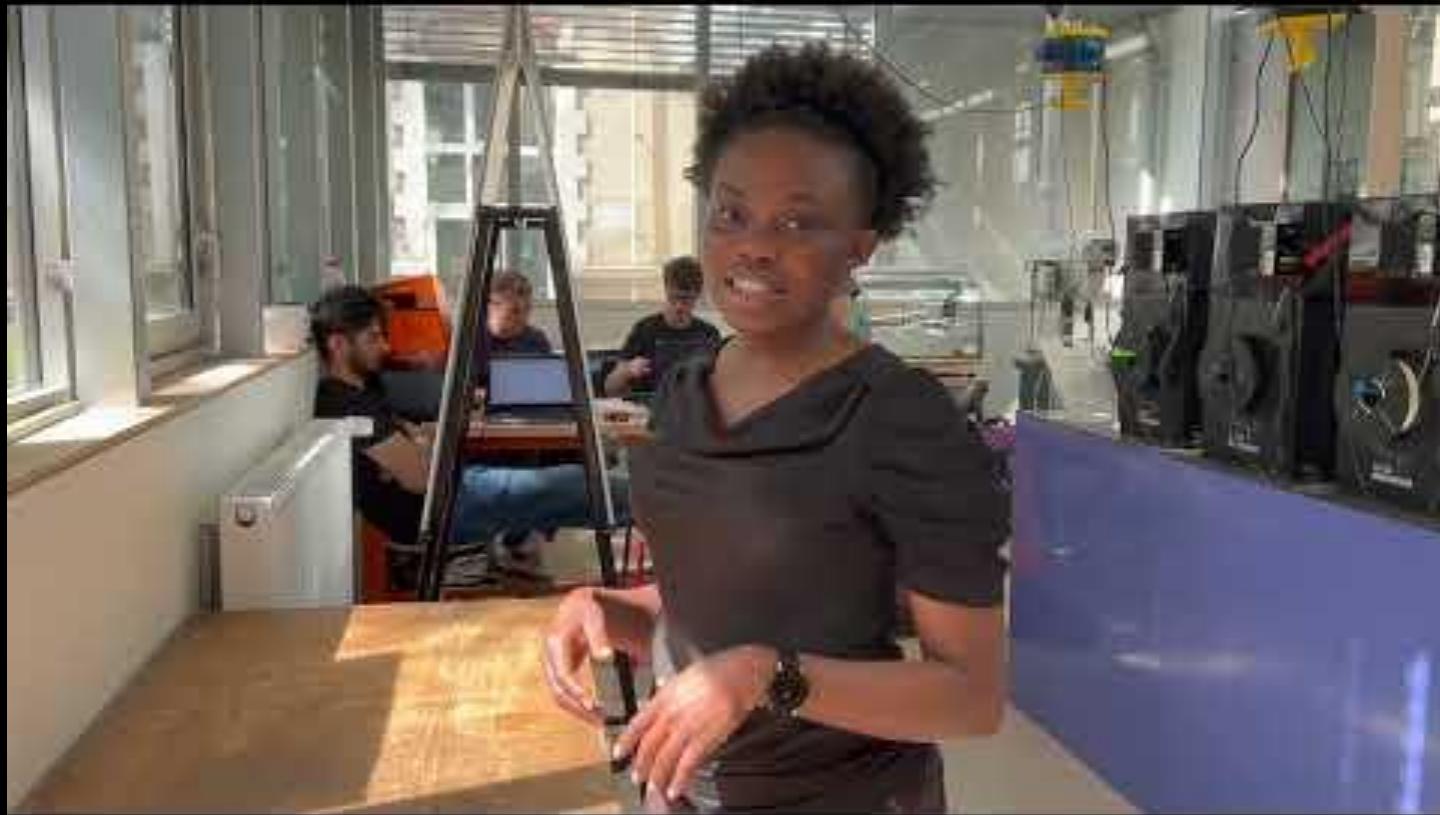
I - CONTEXT OF THE STUDY

fab
MSTIC

To remove all unclear part

Let's watch our
promotional video !





II. Specifications

II - SPECIFICATIONS

fab
MSTIC

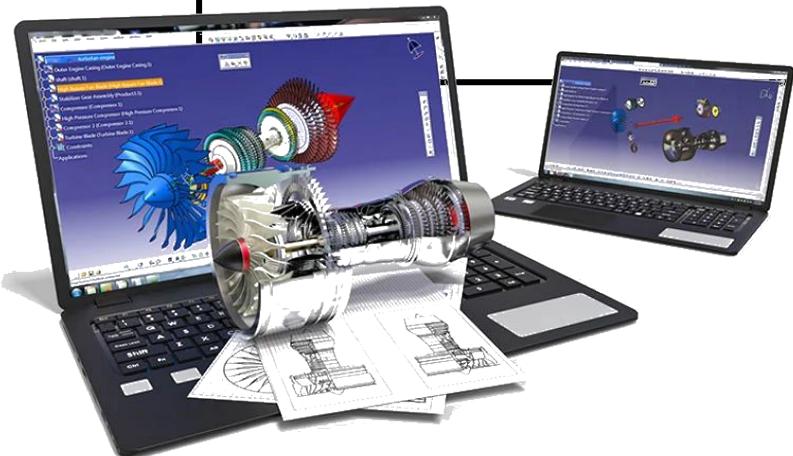
| ID requirement | Name |
|----------------|---|
| FR1 | The shredder needs to work on a standard 220V 50Hz EU plug. |
| FR2 | The shredder needs to respect the 1m50x1mx1m50 maximum volume to avoid cluttering the space. |
| FR3 | The shredder needs to shred plastic into chips with a surface inferior to 150 mm ² with a tolerance of 5%. |
| FR4 | The shredder needs to stop in case of emergency in less than 3 seconds. |
| FR5 | The shredder must be secured to prevent injury on contact (against moving parts and projectiles). |

II - SPECIFICATIONS

fab
MSTIC

| ID requirement | Name |
|----------------|---|
| FR6 | The shredder needs to have a power-on and/or operation indication that the operator can see |
| FR7 | The shredder must not exceed the maximum accepted noise level. |
| FR8 | The shredder should not transform one of the labs and fablabs of the RAFU network into a storage place for all the plastic chips. |
| FR9 | The shredder needs to have a reverse function in case of blocking or any other mechanical problem. |
| FR10 | The shredder and its installation should be stable and strong. |
| FR11 | The shredder need to be able to shred 3D printed plastic part with a 50x50x50 mm dimension and 30 % infill |

III - TECHNICAL AND SCIENTIFIC WORK



fab
MSTIC



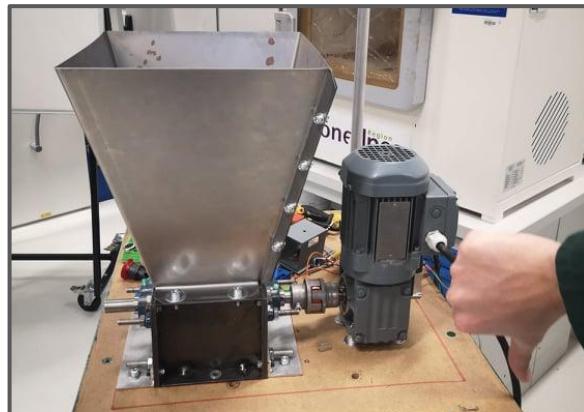
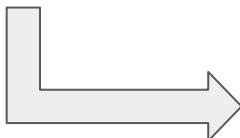
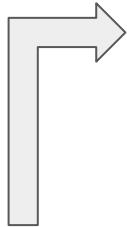
Prototype zero (given) :

- 380 V 3 phases **50 N.m** geared motor
- Incomplete structure
- Precious plastic shredder
- No workbench, no collecting tray



- Only adapted for bottles and light materials
- Lack of security and power

fab
MSTIC



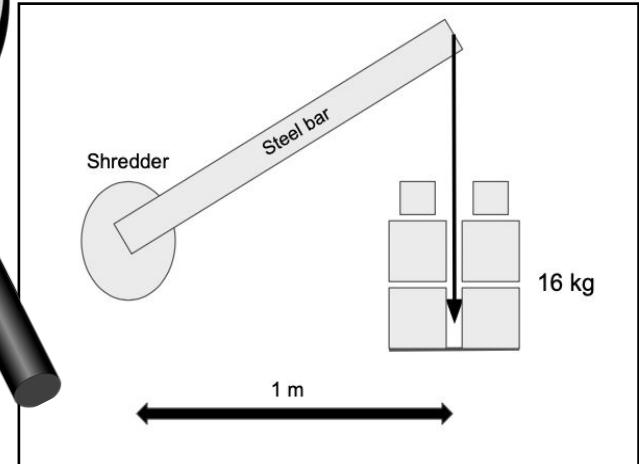
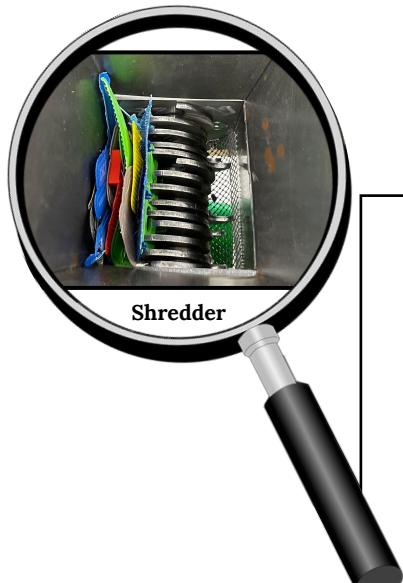
First Prototype :

- 380V 3 phases **60 N.m** geared motor
- Workbench structure with hopper
- Cover with sensor
- **1.5 kw** converter
- Rotex **65 N.m** flexible coupling joints

- Improved **safety**
- Use the maximum the available parts
- Lack of power
- Only adapted for 3D printed rafts

fab
MSTIC

A- Overview step by step



Minimum torque : 200 N.m

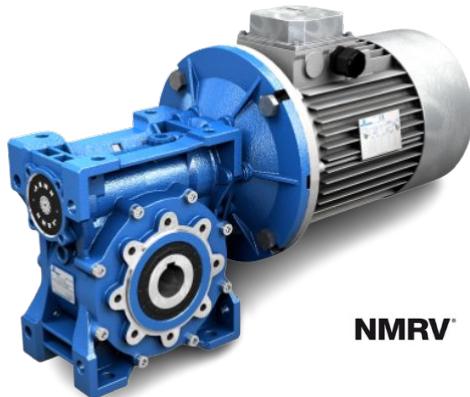
III - TECHNICAL & SCIENTIFIC WORK - motor

fab
MSTIC



Technical information

| | |
|------------------|----------------|
| Voltage | 380V |
| ⚡ AMP | 5.8A |
| - Nominal Power | 1.5 kW minimum |
| - Nominal Torque | 300 Nm minimum |
| - Output Speed | ±70 r/min |

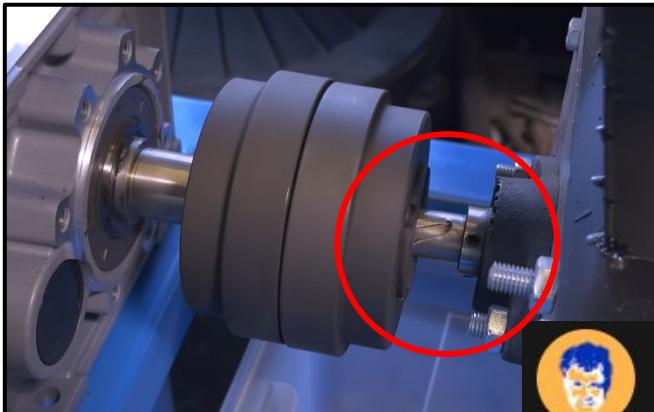


NMRV® NRV® NMRV®
POWER

Motor choice :

- Motovario worm and wheel gearbox
- Output 70 rpm
- 340 N.m output torque

Targeted torque : 300 N.m

fab
MSTIC

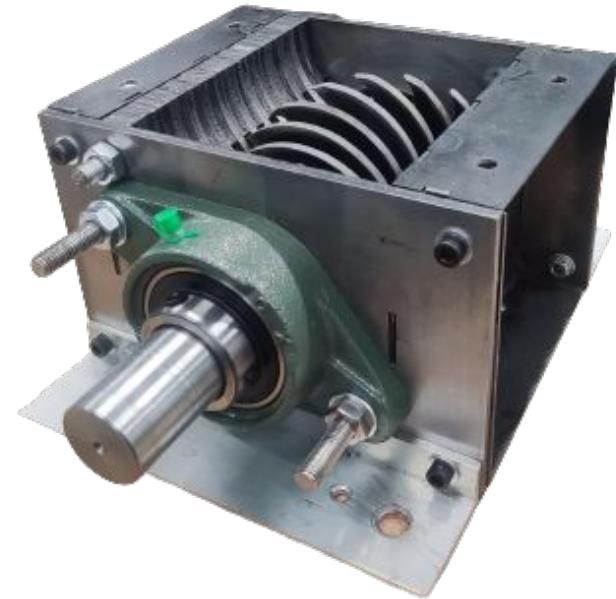
Clement - Izifac
17,3 k abonnés



20 mm original shaft → undersized (maximum calculated of 250 N.m torsion limit with standard steel)

Solutions :

- Change shaft material with harder one (Clement izifac solution)
- Limit the torque with a clutch (electronic or mechanical clutch)
- Oversize the shaft (chosen solution)

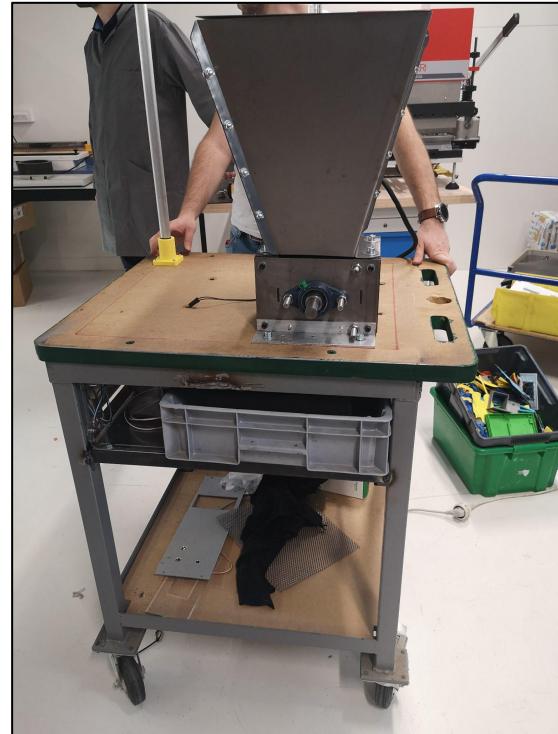
fab
MSTIC

Improvements :

- 35 mm input shaft instead of 20 mm (40 mm hexagonal bar turned on lathe)
- Adapted new bearings
- New cutting blades and spacers

→ Problem with the cutted spacers (5mm instead of 6mm...)

III - TECHNICAL & SCIENTIFIC WORK - other improvements



Global view of the shredder prototype 1 and its structure

IV - SOLUTION AND VERIFICATION OF THE SPECIFICATIONS

unverified

under verification

verified

fab
MSTIC

FR1 and FR9 “The shredder needs to work on a standard 220V 50Hz EU plug.” & The shredder needs to have a reverse function in case of blocking or any other mechanical problem.



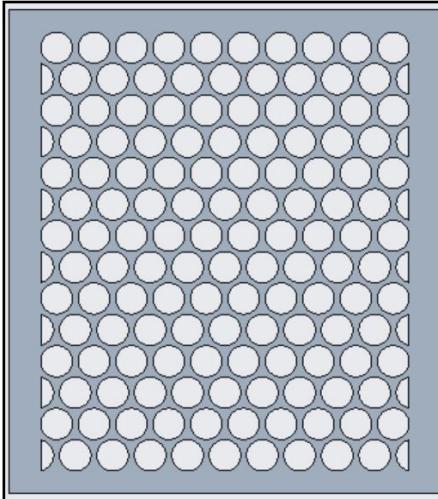
FR2 : “The shredder needs to respect the 1m50x1mx1m50 maximum volume to avoid cluttering the space.”

⇒ Actual size is **750 x 60 x 1400** mm

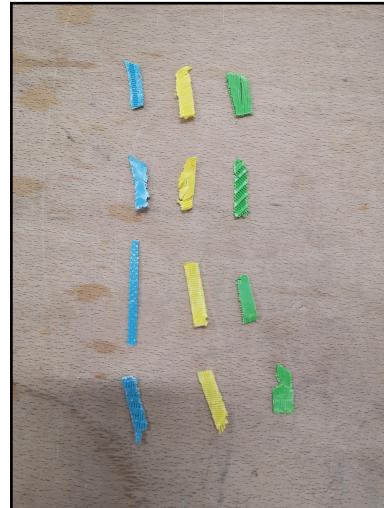


fab
MSTIC

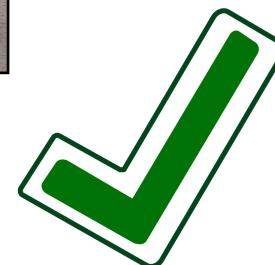
FR3 : “The shredder needs to shred plastic into chips with a surface inferior to 150 mm^2 with a tolerance of 5%.”



FR3 : “The shredder needs to shred plastic into chips with a surface inferior to 150 mm^2 with a tolerance of 5%.”



⇒ **122 mm^2 on average**



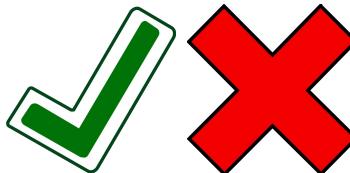
fab
MSTIC

FR4 “The shredder needs to stop in case of emergency in less than 3 seconds.”

⇒ **2,5 sec at most**



FR5 “The shredder must be secured to prevent injury on contact (against moving parts and projectiles).”



fab
MSTIC

FR6 “The shredder needs to have a power-on and/or operation indication that the operator can see”



FR7 “The shredder must not exceed the maximum accepted noise level.”



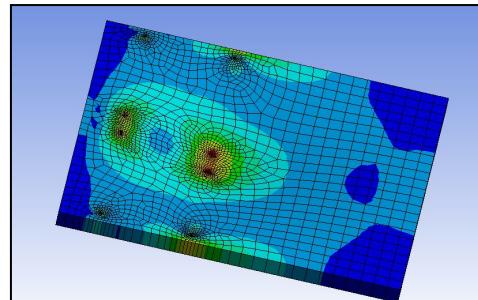
IV - SOLUTION/VERIFICATION OF THE SPECIFICATIONS

fab
MSTIC

FR8 “The shredder should not transform one of the labs and fablabs of the RAFU network into a storage place for all the plastic chips.”



FR10 “The shredder and its installation should be stable and strong.”

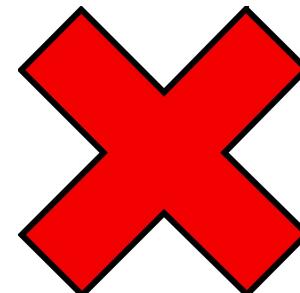


fab
MSTIC

FR11 “The shredder need to be able to shred 3D printed plastic part with a 50x50x50 mm dimension and 30 % infill”



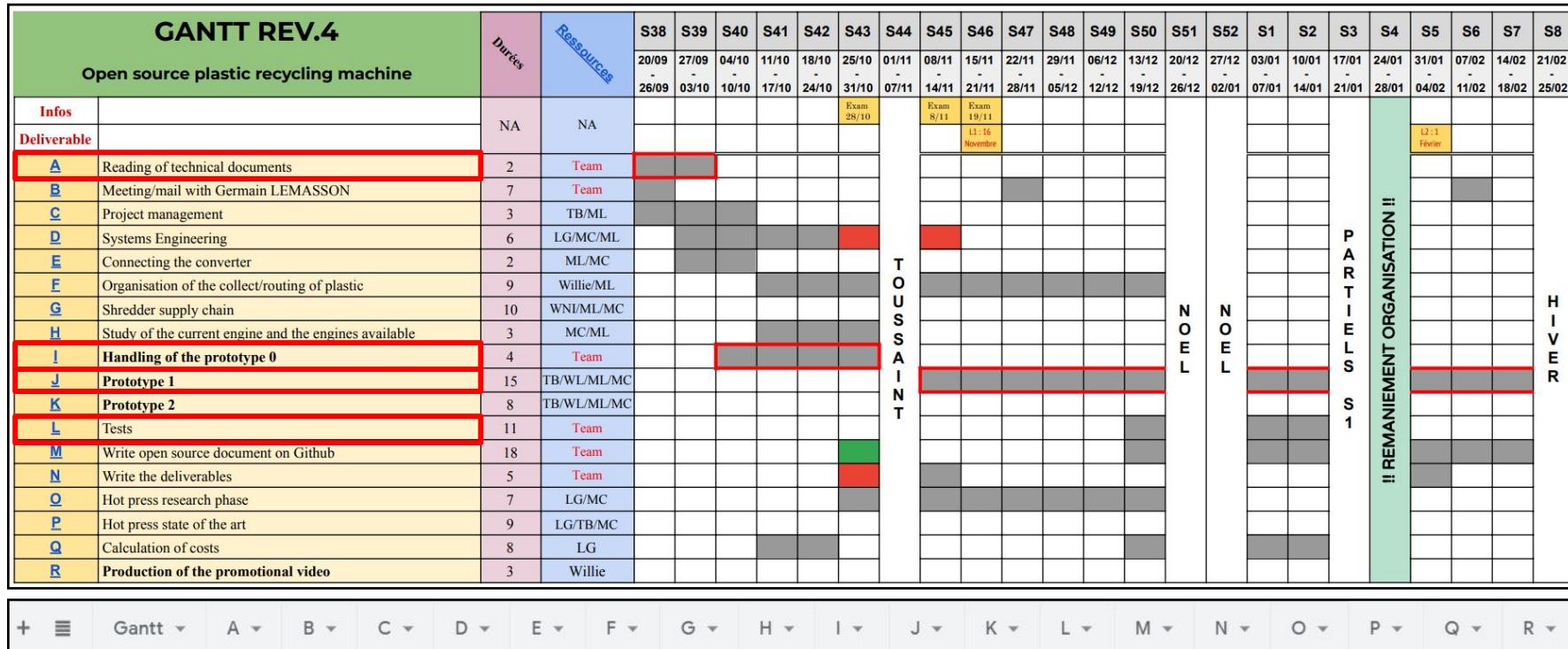
Can't be tested with the new engine



V - PROJECT MANAGEMENT



V - PROJECT MANAGEMENT : GANTT CHART



→ In short : **18** tasks in total / **6** resources / **31** weeks / **4** critical tasks

V - PROJECT MANAGEMENT : GANTT CHART

| GANTT REV.4 | | <i>Durées</i> | <i>Ressources</i> | S38 | S39 | S40 | S41 | S42 | S43 | S44 | S45 | S46 | S47 | S48 | S49 | S50 | S51 | S52 | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|-------------|---|---------------|-------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Infos | Deliverable | | | 20/09 - 26/09 | 27/09 - 03/10 | 04/10 - 10/10 | 11/10 - 17/10 | 18/10 - 24/10 | 25/10 - 31/10 | 01/11 - 07/11 | 08/11 - 14/11 | 15/11 - 21/11 | 22/11 - 28/11 | 29/11 - 05/12 | 06/12 - 12/12 | 13/12 - 19/12 | 20/12 - 26/12 | 27/12 - 02/01 | 03/01 - 07/01 | 10/01 - 14/01 | 17/01 - 21/01 | 24/01 - 28/01 | 31/01 - 04/02 | 07/02 - 11/02 | 14/02 - 18/02 | 21/02 - 25/02 |
| | A Reading of technical documents | 2 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | B Meeting/mail with Germain LEMASSON | 7 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | C Project management | 3 | TB/ML | | | | | | | | | | | | | | | | | | | | | | | |
| | D Systems Engineering | 6 | LG/MC/ML | | | | | | | | | | | | | | | | | | | | | | | |
| | E Connecting the converter | 2 | ML/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | F Organisation of the collect/routing of plastic | 9 | Willie/ML | | | | | | | | | | | | | | | | | | | | | | | |
| | G Shredder supply chain | 10 | WNI/ML/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | H Study of the current engine and the engines available | 3 | MC/ML | | | | | | | | | | | | | | | | | | | | | | | |
| | I Handling of the prototype 0 | 4 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | J Prototype 1 | 15 | TB/WL/ML/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | K Prototype 2 | 8 | TB/WL/ML/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | L Tests | 11 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | M Write open source document on Github | 18 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | N Write the deliverables | 5 | Team | | | | | | | | | | | | | | | | | | | | | | | |
| | O Hot press research phase | 7 | LG/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | P Hot press state of the art | 9 | LG/TB/MC | | | | | | | | | | | | | | | | | | | | | | | |
| | Q Calculation of costs | 8 | LG | | | | | | | | | | | | | | | | | | | | | | | |
| | R Production of the promotional video | 3 | Willie | | | | | | | | | | | | | | | | | | | | | | | |

Critical Task A "Reading the technical documents"

Critical task I "Handling of the prototype 0"

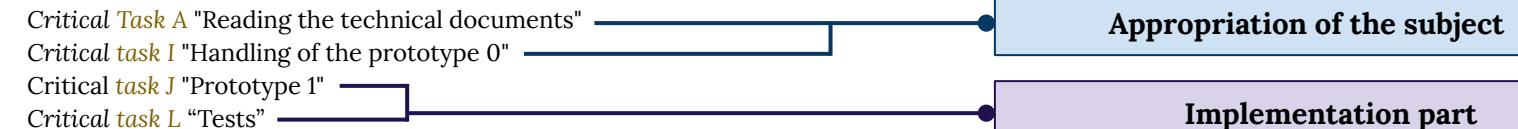
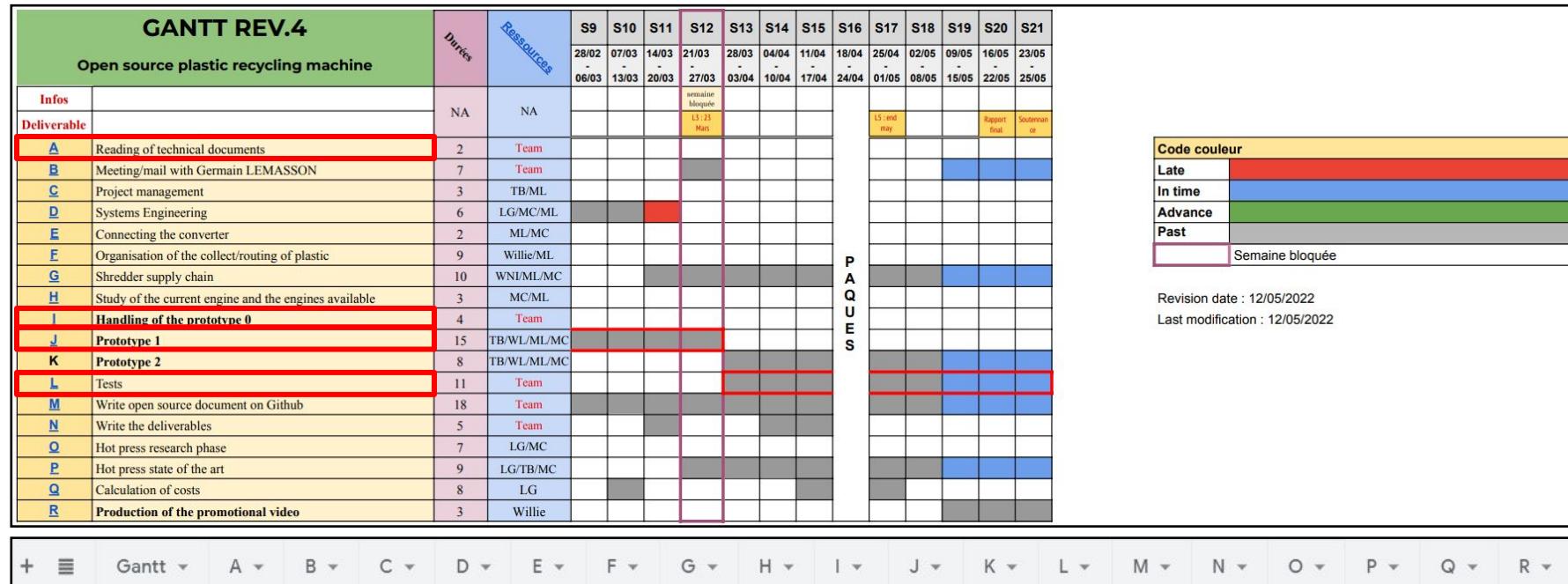
Critical task J "Prototype 1"

Critical task L "Tests"

Appropriation of the subject

Implementation part

V - PROJECT MANAGEMENT : GANTT CHART



V - PROJECT MANAGEMENT : RISK ANALYSIS

1. Project management risks

| Risk family | Risk | ID | Description | Severity (1 to 3) | Occurrence (1 to 3) | Criticality (E*F) | Action taken to avoid the risk |
|---------------|---|-----|--|-------------------|---------------------|-------------------|---|
| Communication | An oversight of client requirements | 1.1 | The customer expected something different to what we produced or want something different without telling us ahead | 3 | 1 | 3 | Maintain regular contact with customers (not just virtually) |
| Communication | Disengagement of some group members | 1.2 | A member of the group decide to leave the project or is continuously absent or sick for a long time. | 2 | 1 | 2 | Establishment of a new organisation such as the repartition of tasks |
| Organization | Work overload some weeks with midterms, other projects, audits... | 1.3 | Delays in planning due to bad forecasts, unforeseen events, etc. | 2 | 2 | 4 | Organise our schedule well and take into account any impediments as much as possible |
| Organization | Delayed orders | 1.5 | Necessary parts are not arrived on time or arrived very late. | 3 | 2 | 6 | We design our products well in advance and take into account the maximum number of parts to be manufactured, ordered. |
| Design | Errors in CAD | 1.7 | There are some errors in the design of the prototype. | 1 | 1 | 1 | Share the work between members to check for errors. To print test parts |

With **FMEA**, we can identify potential failure modes and effects on the system.

V - PROJECT MANAGEMENT : RISK ANALYSIS

| 2. Utilisation risks | | | | | | | |
|----------------------|---|-----|---|-------------------|---------------------|-------------------|--|
| Risk family | Risk | ID | Description | Severity (1 to 3) | Occurrence (1 to 3) | Criticality (E+F) | Action taken to avoid the risk |
| Security | A user is injured by the shredder | 2.1 | A user may be cut by the blades if he does not respect the security chart and other injuries can occur. | 3 | 1 | 3 | Print precise rules of use and put them near the machine |
| Performance | The motor is of a low torque, therefore not enough to shred the plastic | 2.2 | The shredder jams or runs at a very low speed. | 3 | 3 | 9 | To find a new motor/reducer |
| Performance | Unavailability of power supply | 2.4 | The power outage in the lab at time of use | 1 | 1 | 1 | There are always alternative power supply available. |
| Organization | Breaking parts of the prototype | 2.5 | Someone could break a component of the prototype during the mounting or testing phase | 3 | 2 | 6 | List of critical component to handle with care and to have extra parts in advance. |
| Organization | Delayed orders | 2.6 | Necessary parts are not arrived on time or arrived very late. | 3 | 2 | 6 | To prepare extra parts in advance |

→ Dividing it into two parts, makes it more organised and easy to follow.

V - PROJECT MANAGEMENT : COST

| Description | Material | Price | Details | Quantity | Where to get it |
|------------------------|-----------|----------|---------------|----------|---|
| Machine parts | | | | | |
| 3mm pieces | Steel | - € | | 1 | IUT Joseph Fourier - Gr |
| 5mm pieces | Steel | 133,28 € | | 1 | http://www.oxytemp |
| 6mm pieces | Steel | | | 1 | |
| Screw | Steel | - € | M6 x ?? | 8 | |
| Nut | Stainless | - € | M6 | 8 | |
| Washer | Stainless | | M6 | 8 | |
| Hexagonal bar | Steel | 6,92 € | | 1 | https://www.acier-det |
| Bearing | | 22,01 € | UCFL204 Ø20mm | 2 | https://www.123roule |
| Screw | Stainless | 3,10 € | M10 x 60 | 4 | Neton |
| Nut | Stainless | 2,17 € | M10 6 pans | 4 | Neton |
| Threaded shaft | Steel | 1,95 € | Ø10 - 25cm | 2 | Mon brico |
| Nut | Stainless | | M10 6 pans | 4 | |
| Motor/Shft connector | Steel | 2,50 € | Ø60mm L60mm | 1 | https://www.acier-det |
| Screw | Stainless | - € | M8 x ?? | 2 | |
| Structure | Steel | - € | | 1 | Ancien portail |
| Angle profile | Steel | - € | 30*30*3mm | 2 | |
| Washer | Stainless | - € | M10 | 16 | |
| Screw/Shft | Stainless | - € | M10 x 50 | 4 | |
| Nut | Stainless | - € | M10 | 8 | |
| Screw | Stainless | - € | M8 x ?? | 3 | |
| Nut | Stainless | - € | M8 | 3 | |
| Washer | Stainless | - € | M8 | 3 | |
| Mesh sheet | Steel | 0,50 € | 1<Ep<2mm | 1 | Arc-en-ciel |
| Sheet metal for hopper | Steel | 35,20 € | 1<Ep<2mm | 2 | https://www.leroymer |
| Plastic filament | Plastic | 10,00 € | 200 gr | | |
| 3m hex bar | Steel | 133,00 € | 3m | 1 | |
| Bearings | | 50,00 € | | 2 | |
| Structure | | Récup | | 1 | |
| Gear Motor | | | | | |
| Gearmotor | | 839,53 € | | 1 | |

Extract of the cost table

| | | |
|------------------|--|-------------|
| Parts | | 2014,57 € |
| Mechanical parts | | 400,63 € |
| Electric parts | | 774,41 € |
| Motorisation | | 839,53 € |
| Machining | | 237,47 € |
| Ingeneering | | 28 800,00 € |

| | | |
|----------------------------------|--|------------|
| TOTAL PROJECT | | 31052,04 € |
| TOTAL (without ingeneering cost) | | 2252,04 € |

Total cost of the project = 31 052,04€

VI - FOR NEXT YEARS



fab
MSTIC



- Cutting a new wooden table (optional)
- Connecting and attach the new converter
- Mounting the new geared motor
- Manufacture / purchase of a coupling
- Finish assembling the shredder with the new parts (6mm spacers)

- CONCLUSION -

fab
MSTIC

- We realised that **the project is not as cost effective** as had assumed.



- We **missed a few days** to correctly finish the project : the mistake of the spacers cost us a lot in time (5 mm instead of 6 mm).



- **Delay for ordering and receiving** new parts (hexagonal bar and new motor) were excessively long and the **elements arrived at the wrong time** during our midterms.

Thank you for your attention !