BirdBox

Technology in the service of nature

Project Name	Connected nesting box
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Group Number	Group N°10
Project Location	ICAM Strasbourg-Europe
Scrum Master	Andreas ADAIN
Product Owner	Axel MARSACQ

Client: Timothé TURKO	Contractor: ICAM Strasbourg-Europe

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A. Context and objectives reminder

A.1 Context

The connected nesting box is a project initiated as part of the Icam 4 Technical Project, in partnership with the Ligue de Protection des Oiseaux d'Alsace LPO. It **responds to the monitoring and preservation of bird species in urban and peri-urban environments**.

The aim is **to help preserve** two particular species: **the great-tit** “Parus major” and **the black redstart** “Phoenicurus ochruros”.

It **will be installed on the Icam Strasbourg site in early 2025**, contributing to the attractiveness of the campus and raising awareness of biodiversity among students and staff.

The origin of this project comes from the decline of these species. It is often due to the loss of their natural housing, the scarcity of their food and the disruption of their breeding cycles by increasing urbanisation.

The design of an intelligent nesting box **makes it possible to alleviate some of these problems by providing a safe shelter while collecting precise data on their habits and behaviour**.

The table below summarises the key background information.

What ?	Connected nesting box instrumentation system
When ?	2024 / 2025
Where ?	Around ICAM Strasbourg-Europe building
Who ?	LPO, 4th year student, ICAM
How ?	Ecological way
How much ?	300 €
Why ?	Collecting data about the behavior of the birds

A.2 Functional Analysis

The functional analysis below details the system's expected functionality.

Category	Function	Validation criteria	Tolerance	Flexibility
FP1	Measure the temperature	From -25°C to 45°C	+-5°C	F0
FP2	Measure the humidity	Form 10% to 100%	+-5%	F0
FP3	Identify bird species	Three cases : Great-tit , Red-start or neither	30% error max on all the identification at the end of the day	F0
FP4	Count bird	Count until 4 birds at the same time in the nest	+-2	F0
FP5	Measure variation of weight	Can measure a variation of weight until 5kg	+-5g	F0
FP6	Visualize data	user friendly	user 4 years and more	F0

Categories	Function	Validation criteria	Tolerance	Flexibility
FC1	Adaptability of the nest	Nest can be attached to a tree with a diameter between 10 and 40 cm or to a building wall at a height of 3m	+-5 cm for diameter +- 1m for a building wall	FC
FC2	Resistance to all kind of weather	No degradation in winds up to 40 km/h or from sun/rain for 8 months for the instrumentation system and 3 months for the nesting box	Storm, hail and human accident not take into account	FC
FC3	Data security	Make sure that all data are encrypted	0 data leakage	FC
FC4	Minimise birds annoyment	Limit emitted noise until 5 dB	+-2 dB	FC
FC5	Easy installation	Can be assembled in less than 30min	+- 10 min	FC

Category	Function	Validation criteria	Tolerance	Flexibility
FC6	Be autonomous in energy	Energy autonomy of at least 1 year	+-2 months	FC
FC7	Budget	300 €	Tolerance 0	FC
FC8	Security	Nobody gets hurt	Tolerance 0	FC

A.3 Objectives SMART

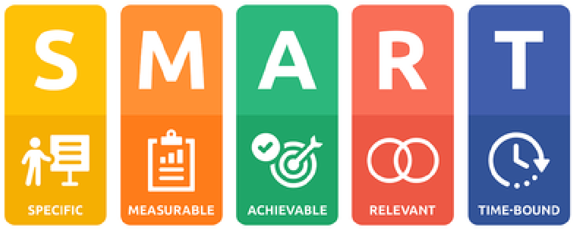
Temperature Measurement

- Specific : Measure the temperature inside the nest.
- Measurable : Range of -25°C to 45°C with a tolerance of ±5°C.
- Achievable : Use appropriate temperature sensors capable of this range and accuracy.
- Relevant : Temperature affects bird health and nesting conditions.
- Time-bound : Continuous monitoring over the project's duration.

Humidity Measurement

- Specific : Measure the humidity inside the nest.
- Measurable : Range from 10% to 100% with a tolerance of ±5%.
- Achievable : Use humidity sensors capable of covering the entire range.
- Relevant : Humidity impacts nesting material and bird comfort.
- Time-bound : Continuous monitoring over the project's duration.

A.3 Objectives SMART



Bird Counting

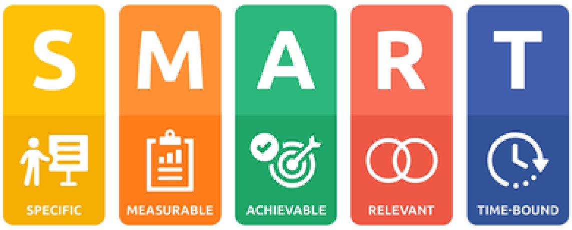
- **Specific :** Count the number of birds inside the nesting box.
- **Measurable :** Accurate within ±2 birds, with a maximum count of 4 birds simultaneously.
- **Achievable :** Utilize weight sensor.
- **Relevant :** Understanding bird occupancy is crucial for data collection.
- **Time-bound :** Real-time monitoring throughout the day.

Species Identification

- **Specific :** Identify whether the birds are great tits, black redstarts, or neither.
- **Measurable :** Ensure a maximum error margin of 30% by the end of each day.
- **Achievable :** Use image recognition software and bird call analysis.
- **Relevant :** Knowing bird species helps in studying biodiversity and bird behaviors.
- **Time-bound :** Provide species identification results at the end of each day.

Energy Autonomy

- **Specific :** The system must be energy self-sufficient.
- **Measurable :** Operate autonomously for at least one year, with a tolerance of ±2 months.
- **Achievable :** Implement energy-efficient hardware.
- **Relevant :** Ensures continuous operation without manual battery changes.
- **Time-bound :** One-year operational period.



Environmental Durability (Instrumentation system)

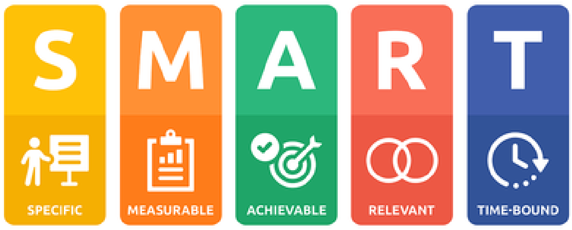
- Specific : The system should resist weather-related degradation.
- Measurable : Show no signs of degradation due to sun or rain for 8 months, withstand winds up to
- 40 km/h.
- Achievable : Use robust construction.
- Relevant : Ensures system reliability in outdoor conditions.
- Time-bound : 8-month weather durability

Weight Variation Measurement

- Specific : Measure the weight of the nesting box.
- Measurable : Detect changes up to a maximum of 5 kg with a tolerance of ±5 g.
- Achievable : Use precision load cells or weight sensors.
- Relevant : Weight changes can indicate nest activity.
- Time-bound : Continuous monitoring.

Data Transmission and Interface

- Specific : Transmit data to a user-friendly interface.
- Measurable : Display hourly data updates suitable for ages 4 to seniors.
- Achievable : Design a simple, intuitive interface with large icons and minimal text.
- Relevant : Makes data accessible to a broad audience.
- Time-bound : Hourly data updates.



Data Security

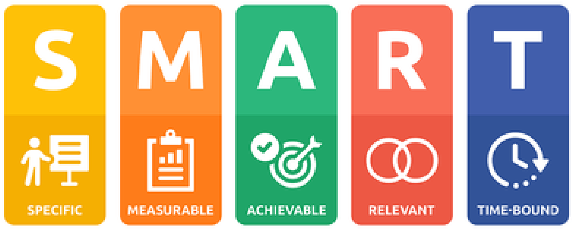
- **Specific :** Ensure encrypted data transmission.
- **Measurable :** Zero tolerance for data leakage.
- **Achievable :** Use strong encryption protocols.
- **Relevant :** Protects sensitive information from unauthorized access.
- **Time-bound :** Continuous encryption throughout the project.

Noise Emission

- **Specific :** Limit noise emitted by the system.
- **Measurable :** Maintain noise levels below 5 dB, with a tolerance of ±2 dB.
- **Achievable :** Use silent components.
- **Relevant :** Prevents disturbance to birds and the surrounding environment.
- **Time-bound :** Continuous noise control.

Mounting Adaptability (Nesting Box)

- **Specific :** Adapt to various mounting locations.
- **Measurable :** Fit tree diameters from 10 to 40 cm (±5 cm) and mountable on walls at heights of 3 m (±1 m).
- **Achievable :** Use adjustable straps and versatile mounting systems.
- **Relevant :** Ensures the nesting box can be used in diverse environments.
- **Time-bound :** Ready for mounting upon installation.



Environmental Durability (Nesting Box)

- Specific : Resist weather-related degradation.
- Measurable : Show no signs of degradation for at least 3 months under sun or rain.
- Achievable : Use UV-resistant materials and waterproof coatings.
- Relevant : Ensures the nesting box remains functional and secure.
- Time-bound : 3-month weather durability.

Budget Compliance

- Specific : Complete the project within the allocated budget.
- Measurable : Do not exceed 300€.
- Achievable : Optimize costs for materials and components.
- Relevant : Ensures financial feasibility.
- Time-bound : Budget tracked throughout the project life-cycle.

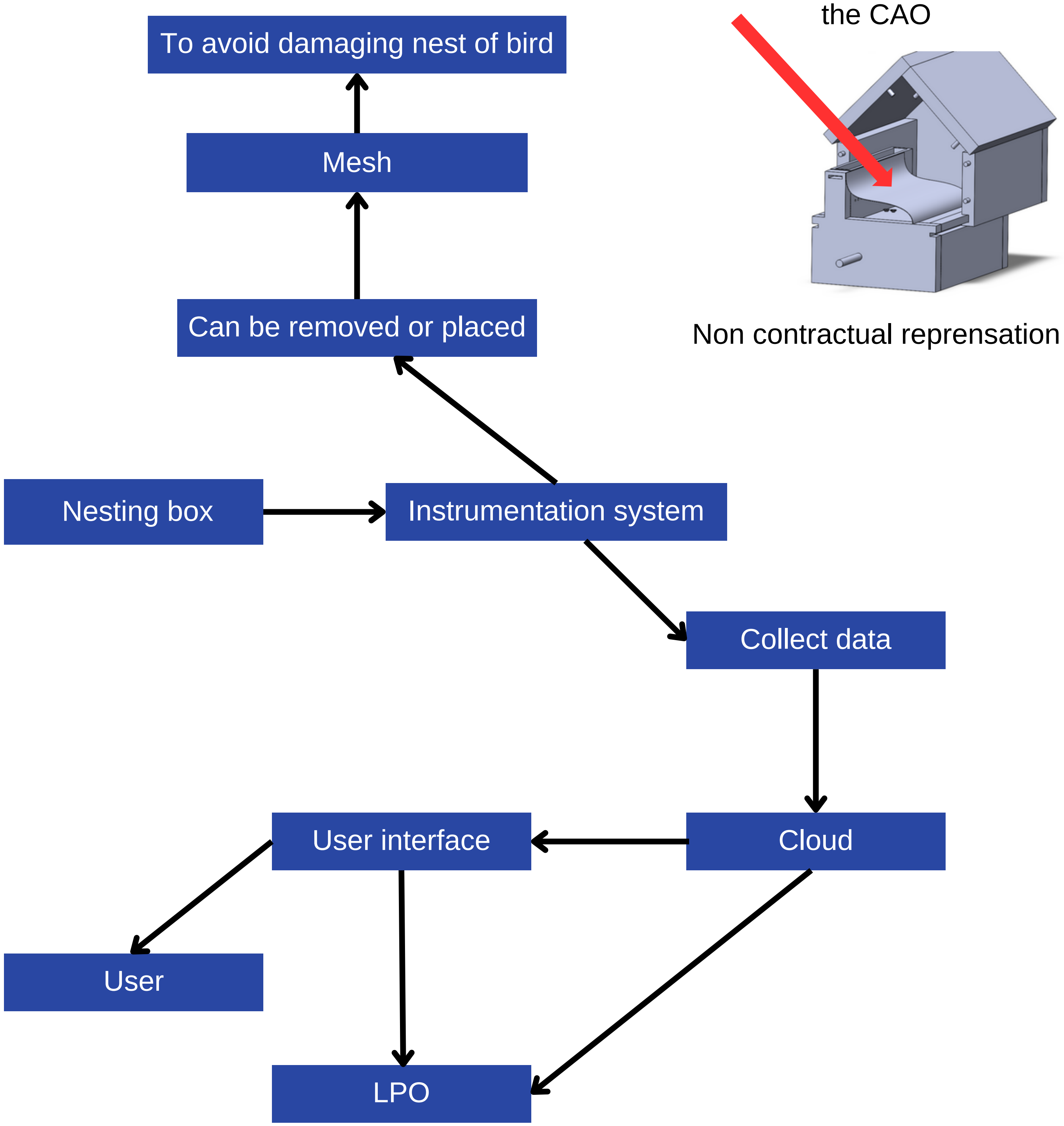
Safety Compliance

- Specific : Ensure safety throughout the project.
- Measurable : Zero tolerance for safety violations.
- Achievable : Follow safety guidelines for equipment use and mounting.
- Relevant : Prevents injuries and ensures the well being of people and wildlife.
- Time-bound : Safety maintained from start to project completion.

A.4 Global architecture

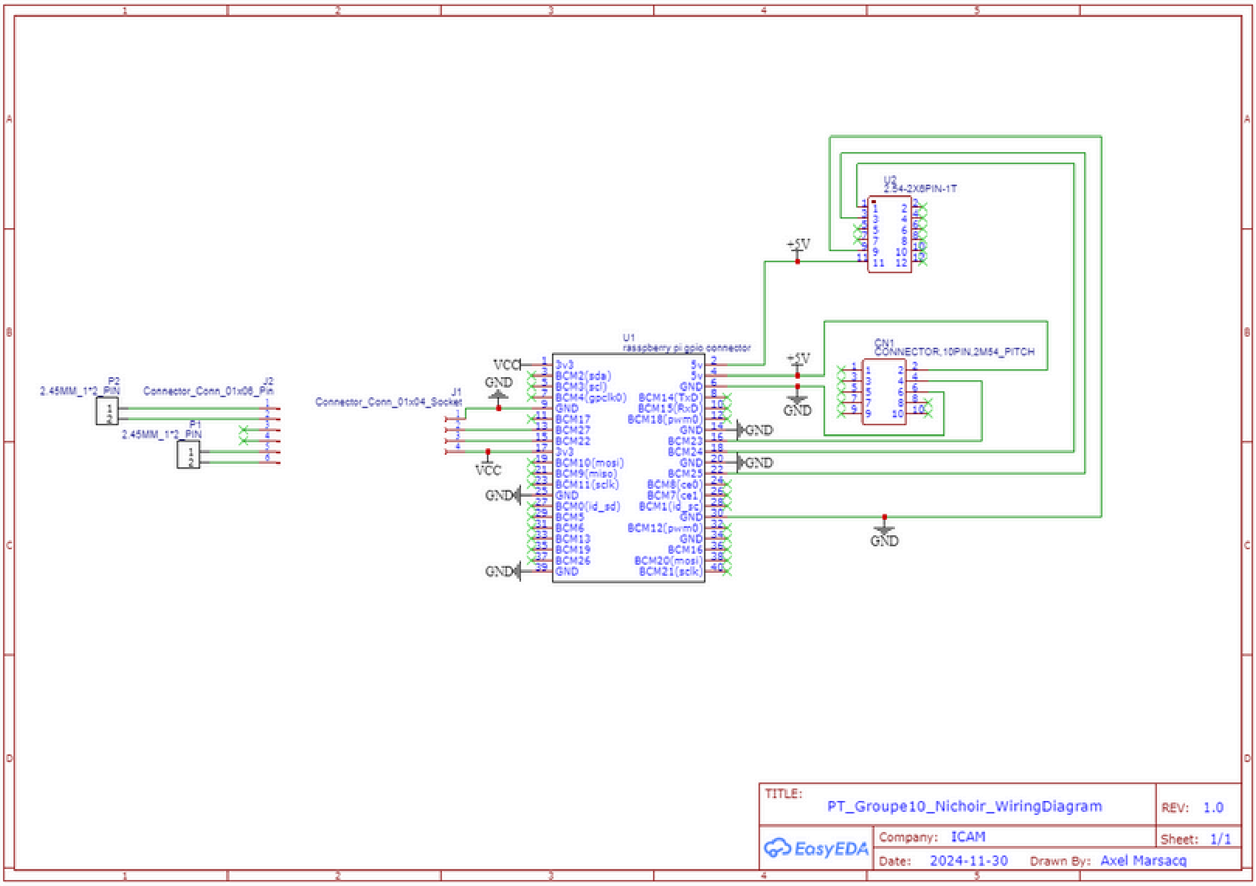
The overall architecture shown below provides an overview of the system's main components and their interactions.

This is a representation of the mesh i the CAO

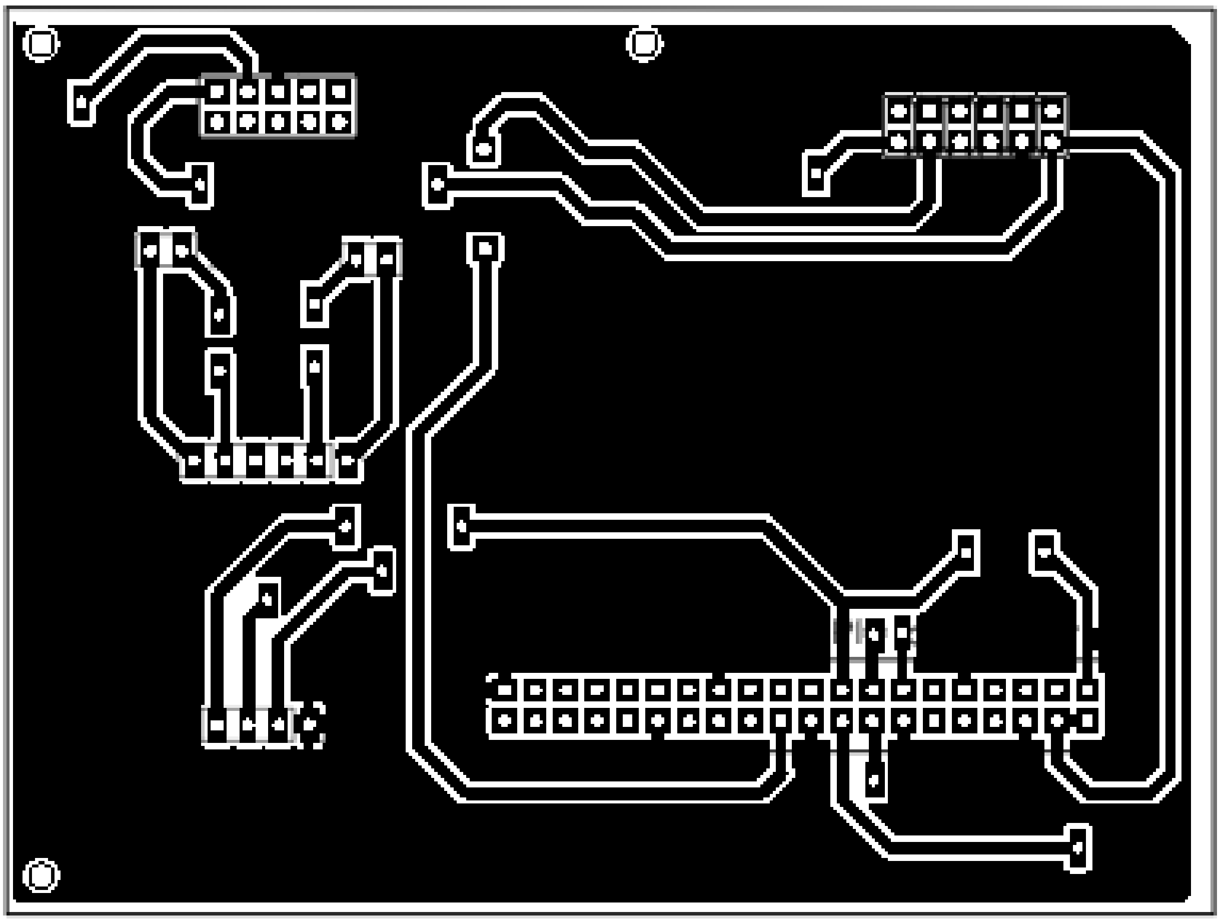


B. Wiring Diagrams

B.1 Wiring diagram

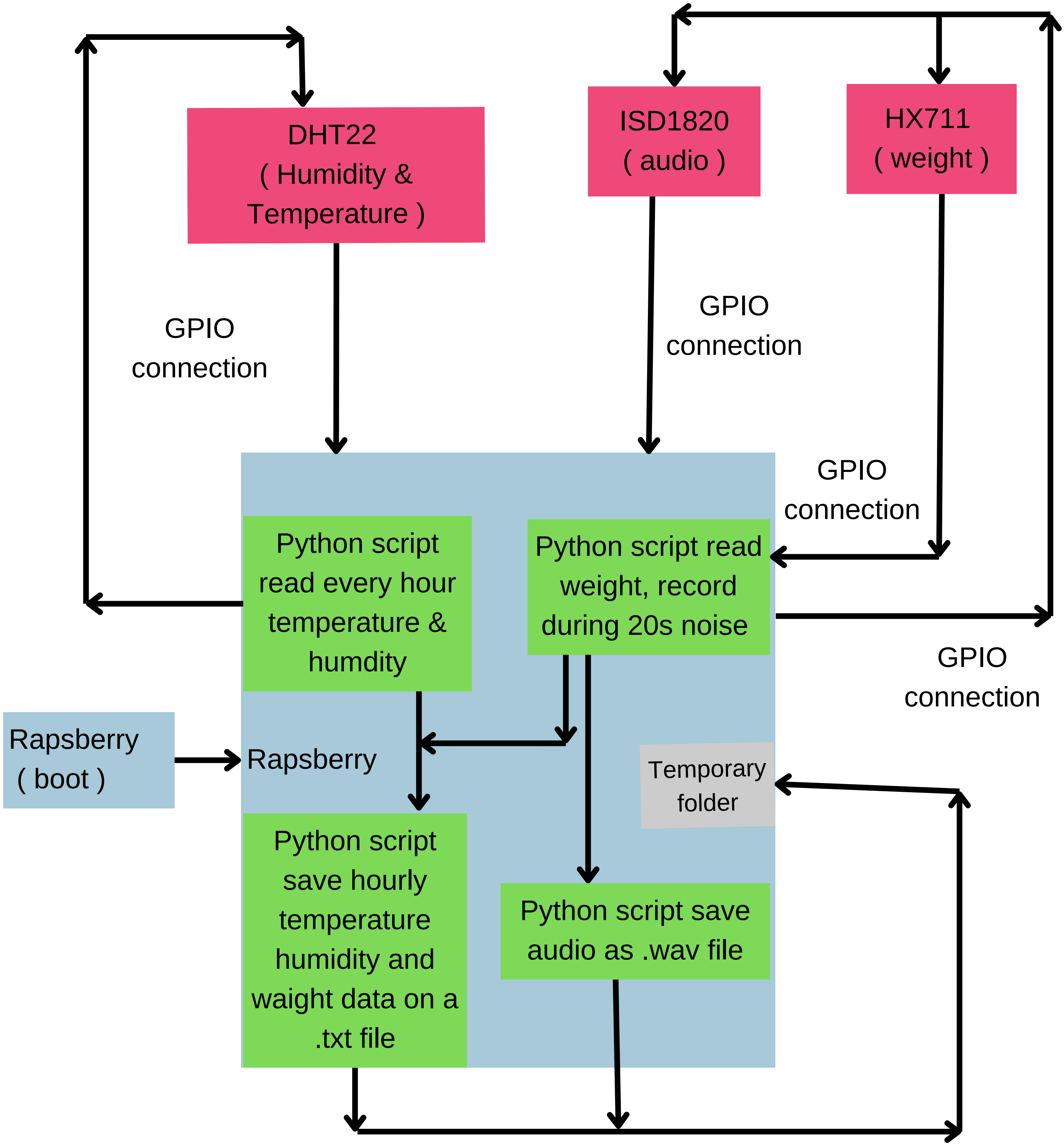


B.2 PCB

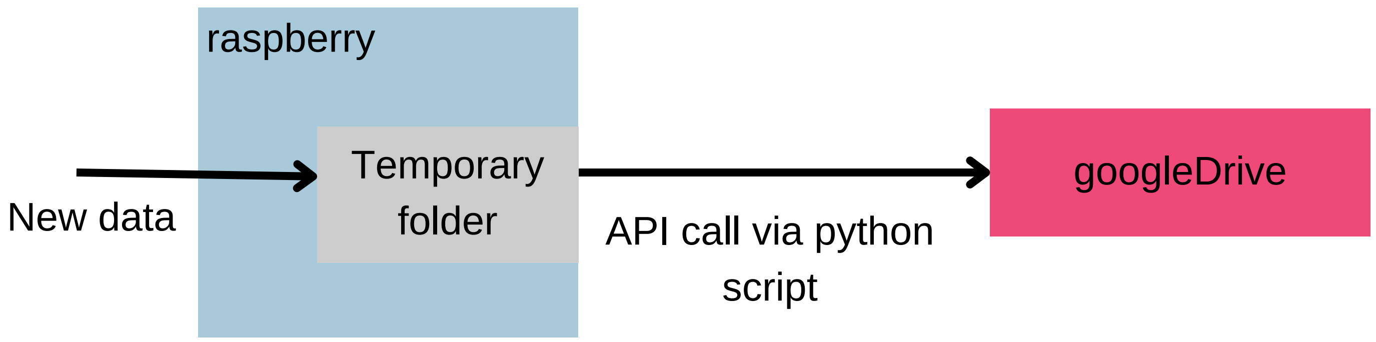


C. Software Algorithms (No code)

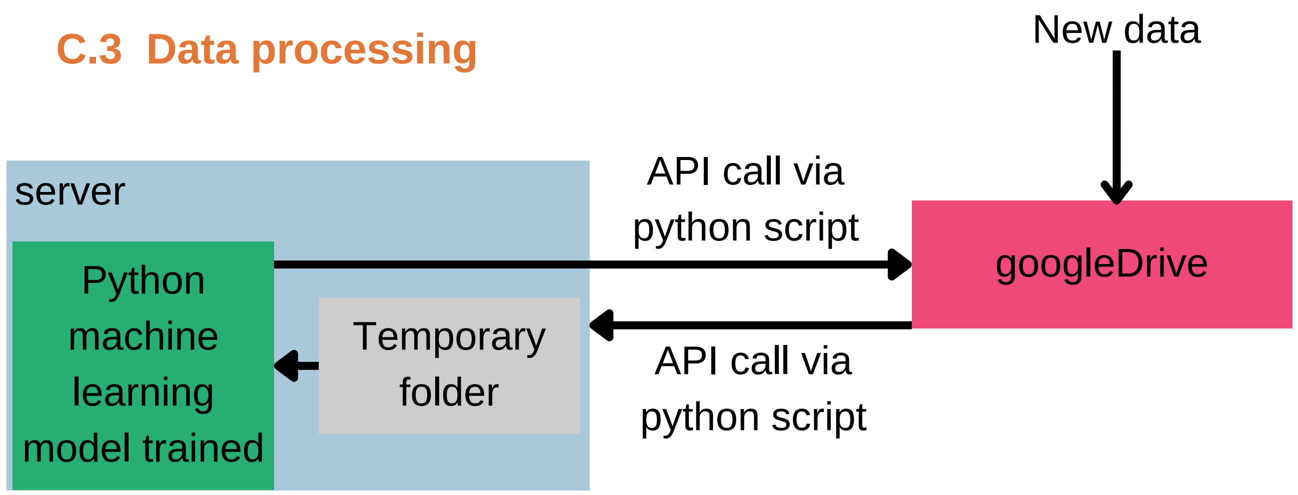
C.1 Data acquisition



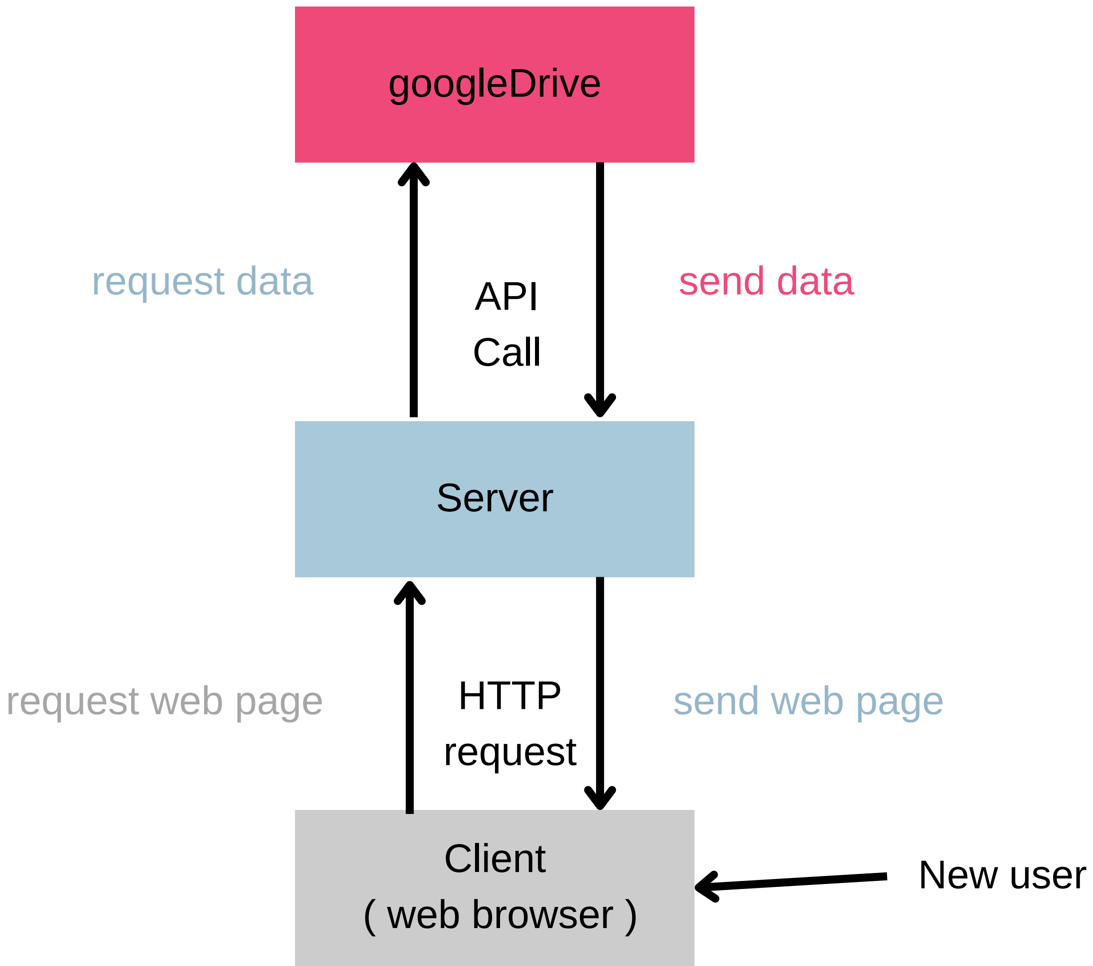
C.2 Data transmission



C.3 Data processing

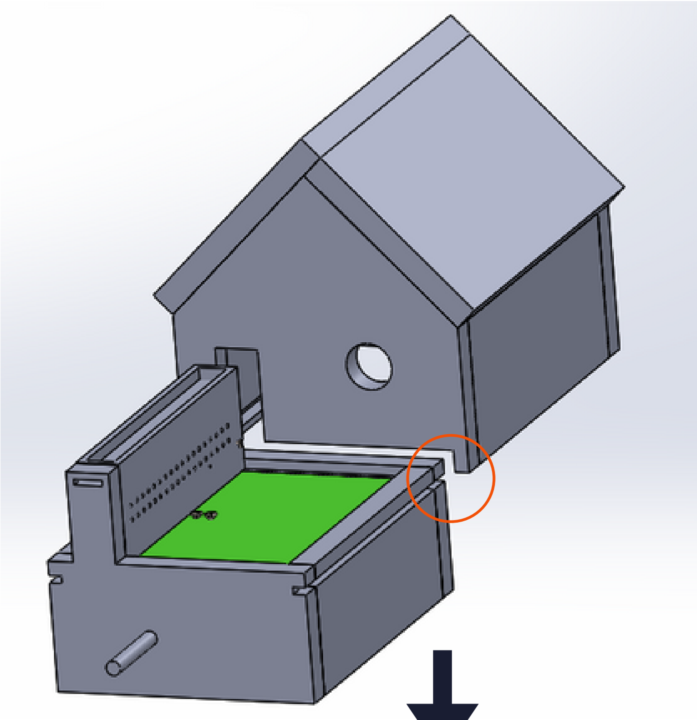


C.4 Data visualisation



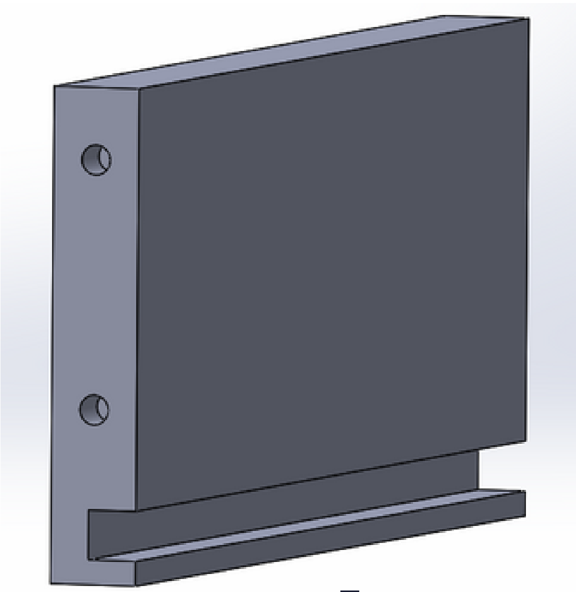
D. Calculation and simulation results

D1. Location of the Simulation



In order to be sure that the nesting box will resist to all kind of environmental constraints, we ran one specific simulation.

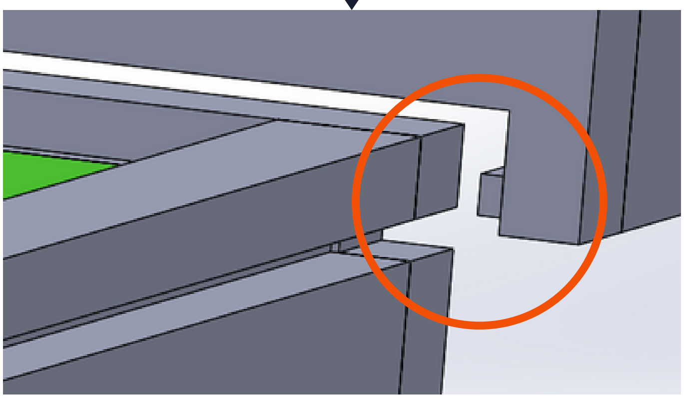
Indeed, the most important place where the nesting box could possibly break is the link between the instrumentation box and the nesting box itself.



With the help of the Nastran software, we are able to simulate the pressure applied on the runner.

Knowing that the system is symetric, we use as data of the mass half of the total weight of the box instrumentation

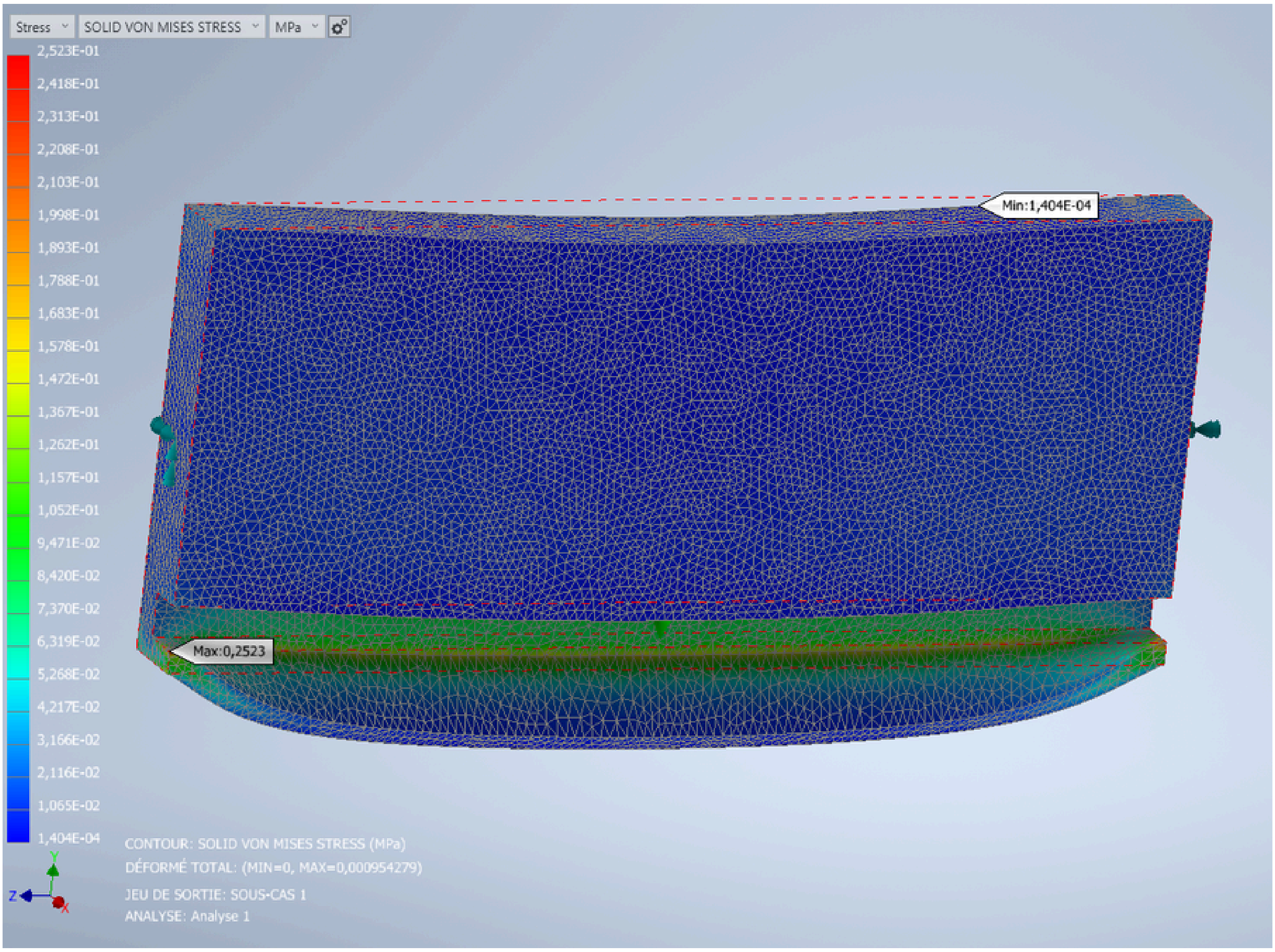
(2,101kg/2=1,052kg).



$$P = \frac{m.g}{S} = \frac{1{,}052.9{,}81}{0{,}002} = 5161{,}06\ Pa$$

From the simulation we can conclude if we need to make the groove of the instrumentation box wider.

D2. Nastran Simulation



According the CAO of the nesting box, both of the lateral parts have a fixed constraints. They are represented by the arrows on the lateral side on the simulation above.

From the results of the simulation, it is now possible to compare the elsatic limit maximal of the material (pine tree wood) E=10 000MPa which is and the maximal stress obtained with Nastran (Max=0,2523MPa)

D3. Calculation

Flexion

Here is the calculation of the Von Mises stress in order to see where are the deformation constraints located.

Data:
Strength: F=417,57N
Length: L=0,23m
Inertia momentum: I=1,875.10^-4 m^-4

Calculation:

$$\sigma_{VM} = \frac{F.L.h/2}{I} = \frac{417{,}57.0{,}23.0{,}0025}{1{,}875.10^{-4}} = 1280{,}55Pa$$

It is important to be calculated to measure the local intensity of stresses within the material. If this stress remains below the yield strength (10 000MPa), the material will not undergo plastic deformation, but this does not guarantee a small elastic deformation.

From the calculation, we can now conclude that both of the Von Mises stress of obtained with Nastran tell us that the nesting box will be able able to support the instrumenattion box.

E. Manufacturing and assembly procedure

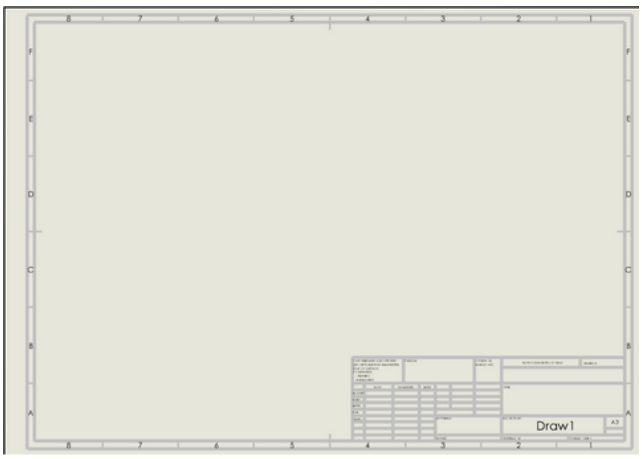
In the following sections, I will present the manufacturing plan for each piece, detailing the processes and steps required to produce them. Additionally, the definition drawings of all manufactured parts will be included. These drawings provide precise specifications and dimensions, ensuring clarity and accuracy in the manufacturing process. This comprehensive documentation aims to facilitate production and guarantee that the design intentions are accurately realized.

It is important to note that dimensional and geometric tolerances have not been included in this documentation. This decision stems from the fact that the machines currently available can neither achieve these specific tolerances nor control them accurately. As a result, the drawings presented concentrate on the nominal dimensions required to manufacture the parts, while simplifying the requirements to suit existing production capacity.

Exemple:

Part number : DXXX - X
Raw material : DXXX - X

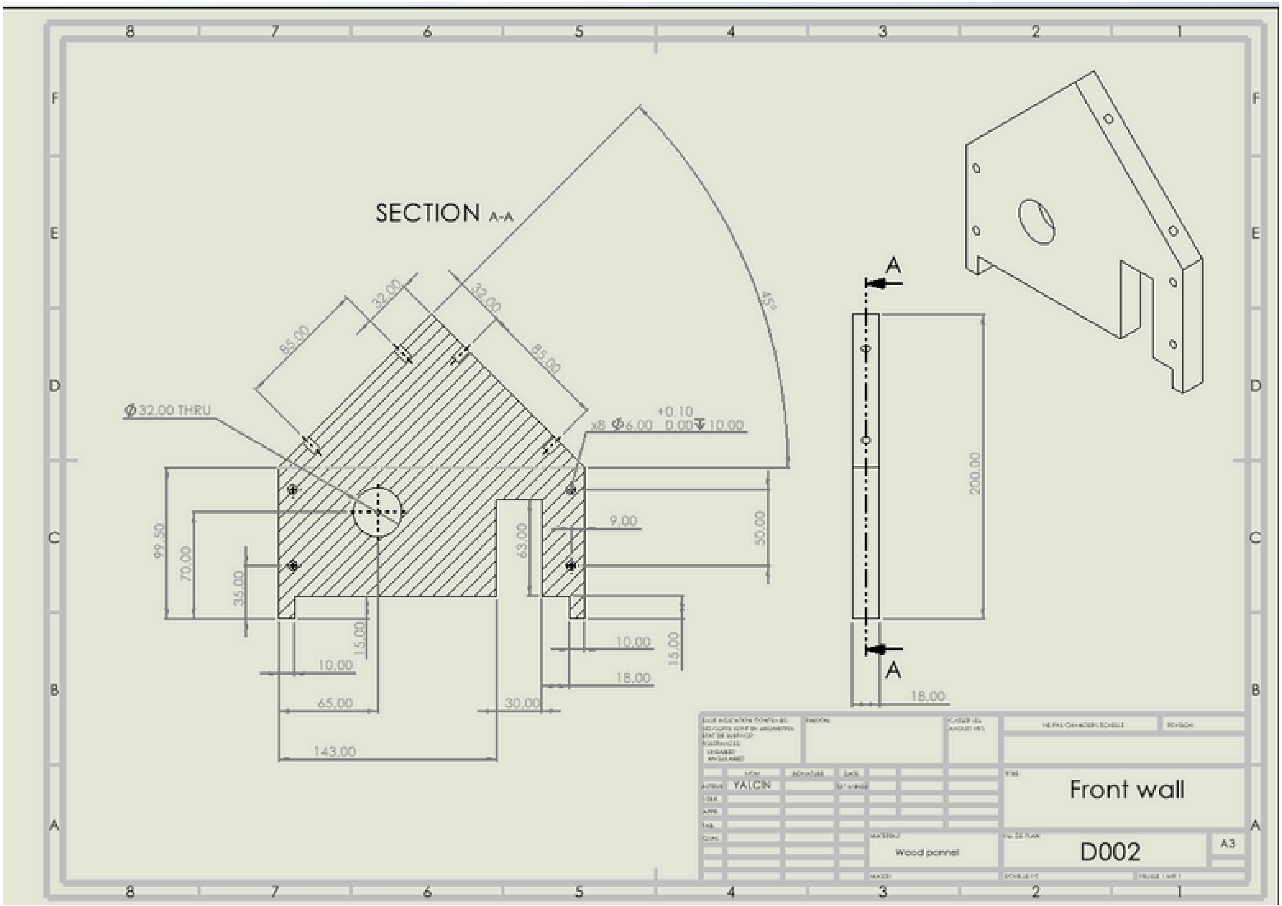
Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1						
2						
3						
4						
5						



E.1 Manufacturing plan & Detail drawing of all manufactured part

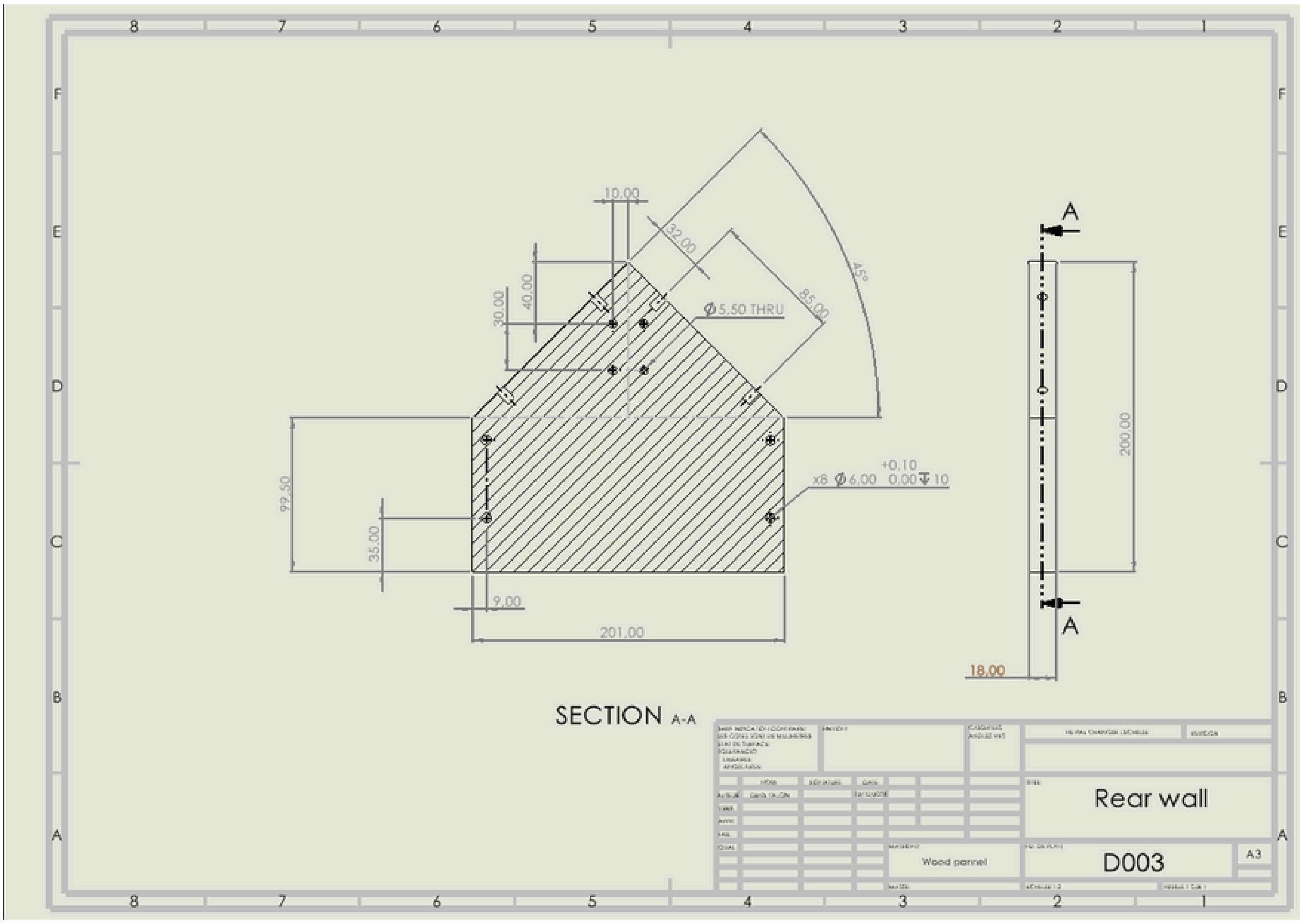
Part number : D002 - Front wall
Raw material : D001 - *Wood pannels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60’	Cut the wooden material to a board of 200mmx 201 mm. And add a 45-degree angle cut on the top edge to form a roof shape. (201mm is correct).	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D002_Detail_Drawing
2	60’	Drill the circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D002_Detail_Drawing.
3	120’	Machine the open slot and the circular pocket.	lab02 milling machine	End mill (suitable for wood)	1 operator	D002_Detail_Drawing and machining program.
4	60’	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D002_Detail_Drawing.
5	60’	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D002_Detail_Drawing.



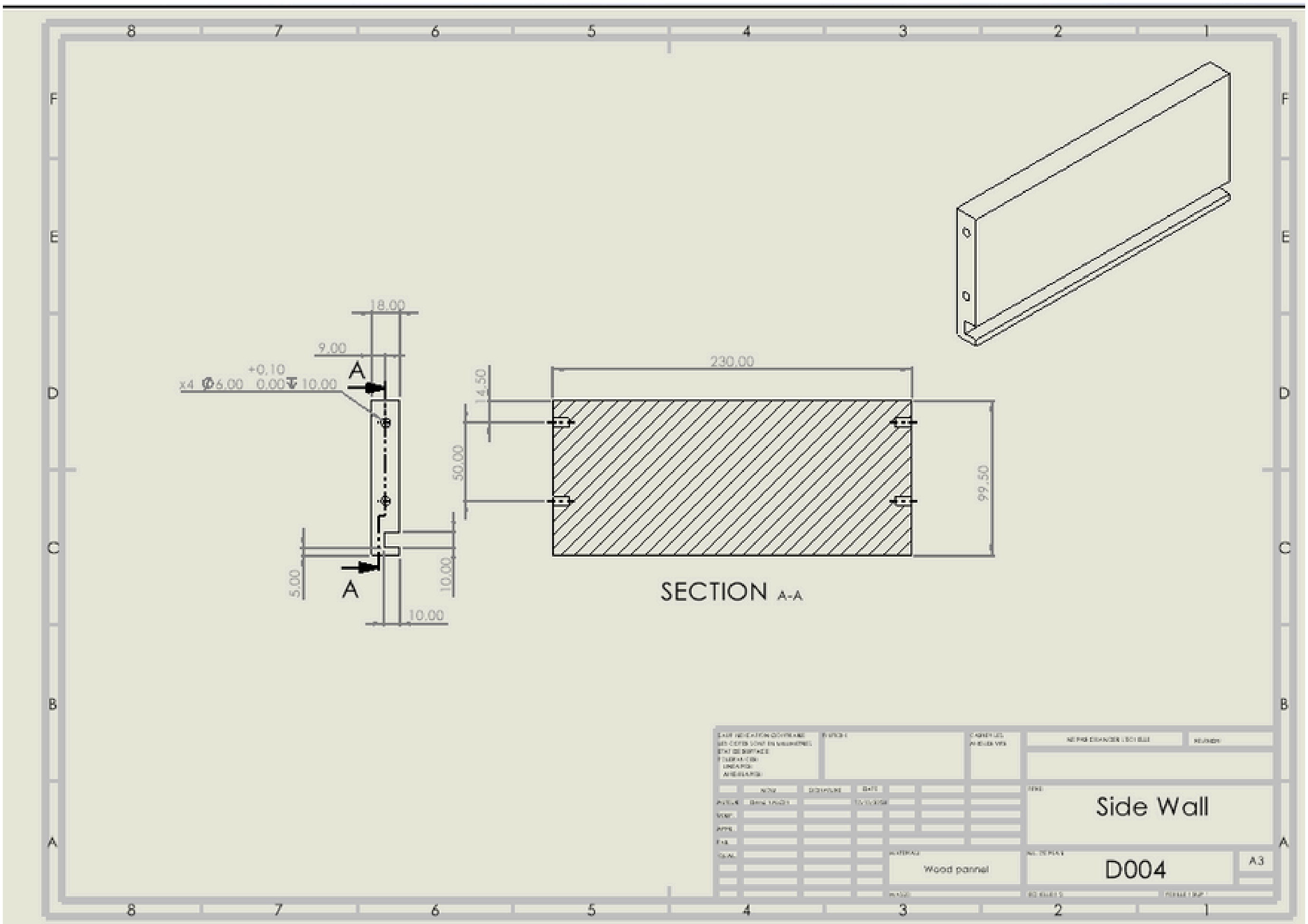
Part number : D003 - Rear wall
Raw material : D001 - *Wood pannels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wooden material to a board of 200mmx 201 mm. And add a 45-degree angle cut on the top edge to form a roof shape. (201mm is correct).	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D003_Detail_Drawing
2	60'	Drill the 8 circular holes of diameter 6mm at the specified location to a depth of 10mm. And drill 4 holes of 5.5mm diameter specified location.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D003_Detail_Drawing
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D003_Detail_Drawing
4	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D003_Detail_Drawing



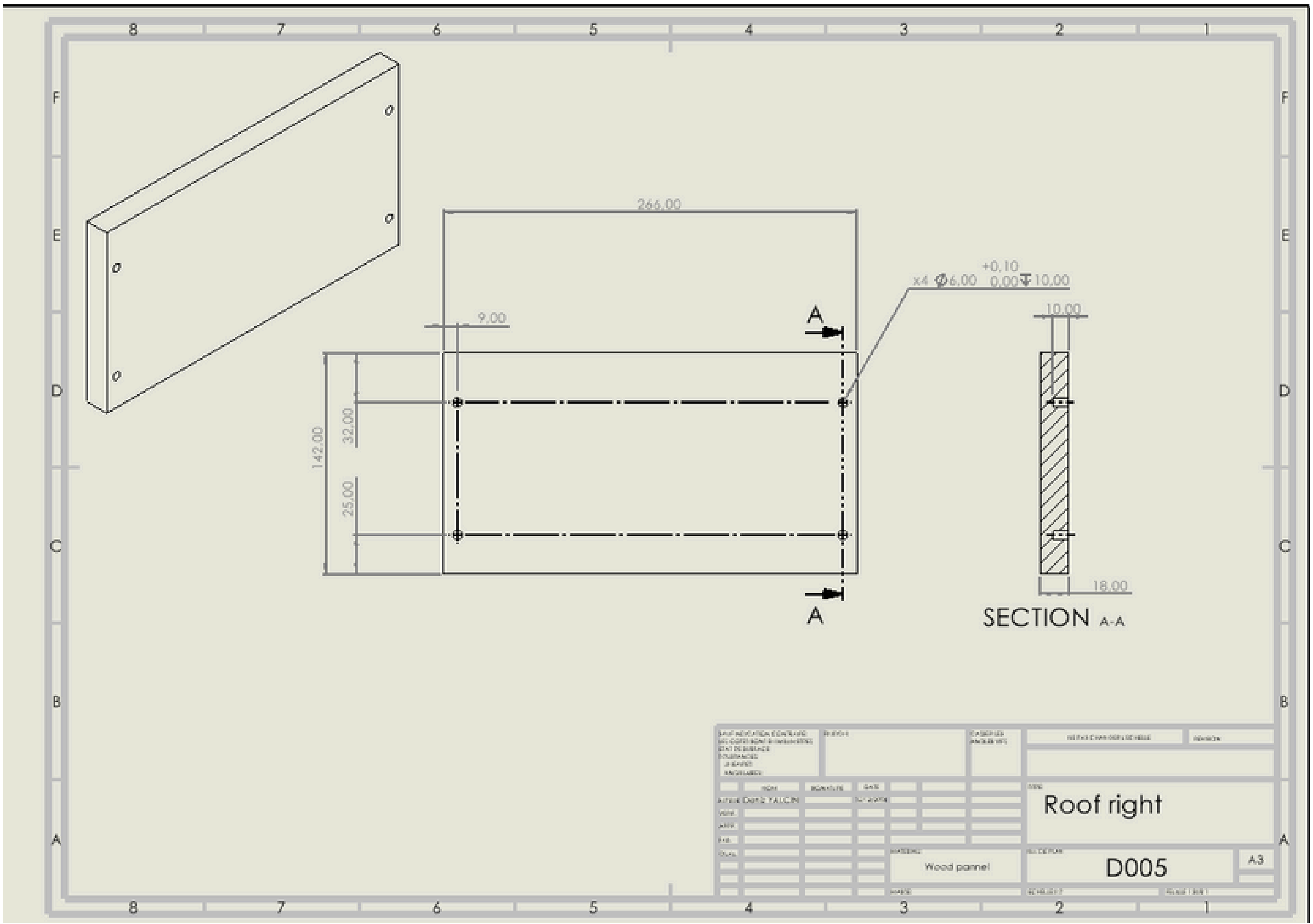
Part number : D004 - Side Wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wood panel to a board of 230mm x 99.5 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D004_Detail_Drawing
2	60'	Drill the 4 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D004_Detail_Drawing
3	60'	Machine the slot to a depth of 10mm	lab02 milling machine	End mill (suitable for wood)	1 operator	D004_Detail_Drawing and machining program.
4	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D004_Detail_Drawing
5	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D004_Detail_Drawing



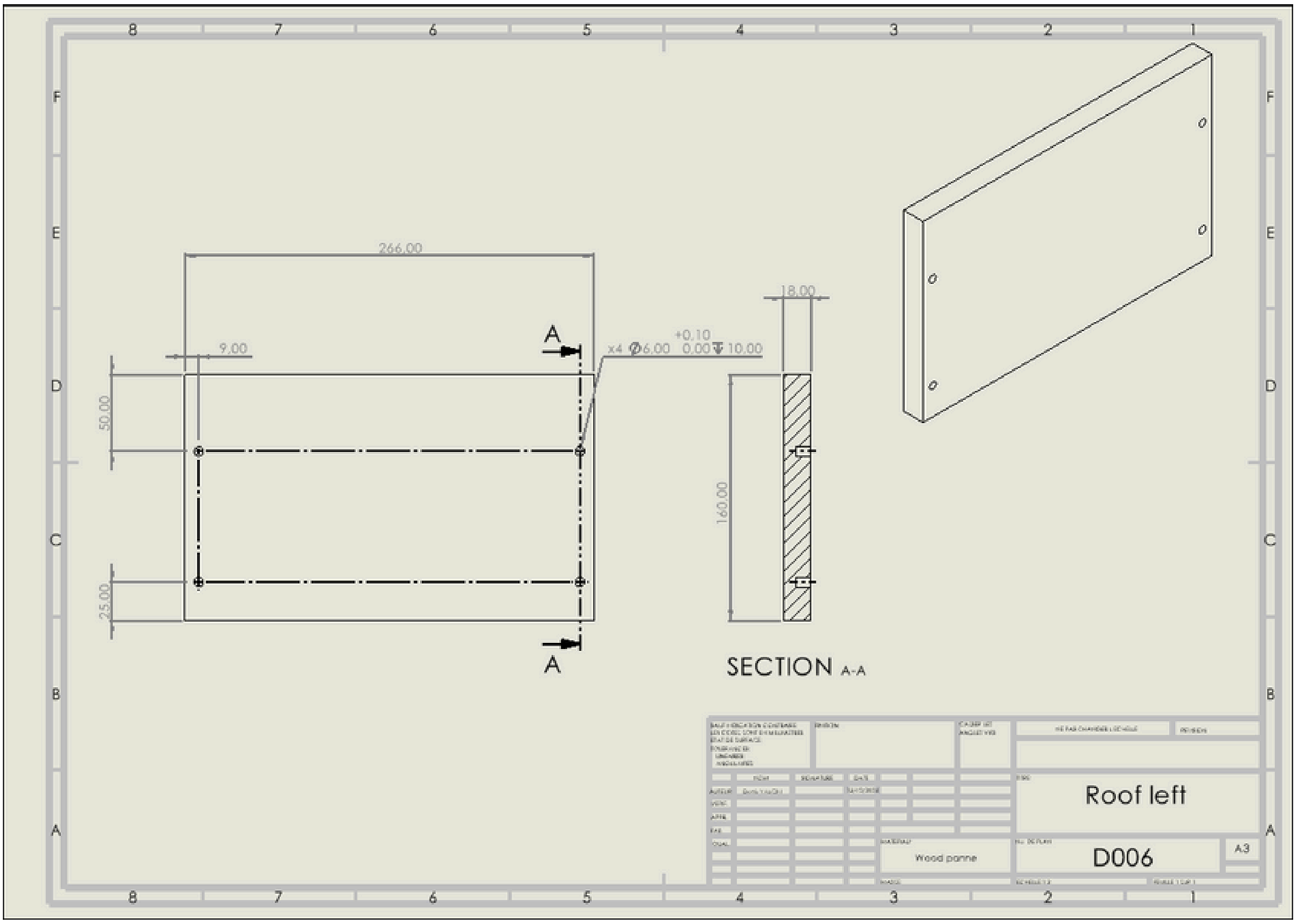
Part number : D005 - Roof right
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wooden material to a board of 266 mm x 142 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D005_Detail_Drawing
2	60'	Drill the 4 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D005_Detail_Drawing
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D005_Detail_Drawing
4	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D005_Detail_Drawing



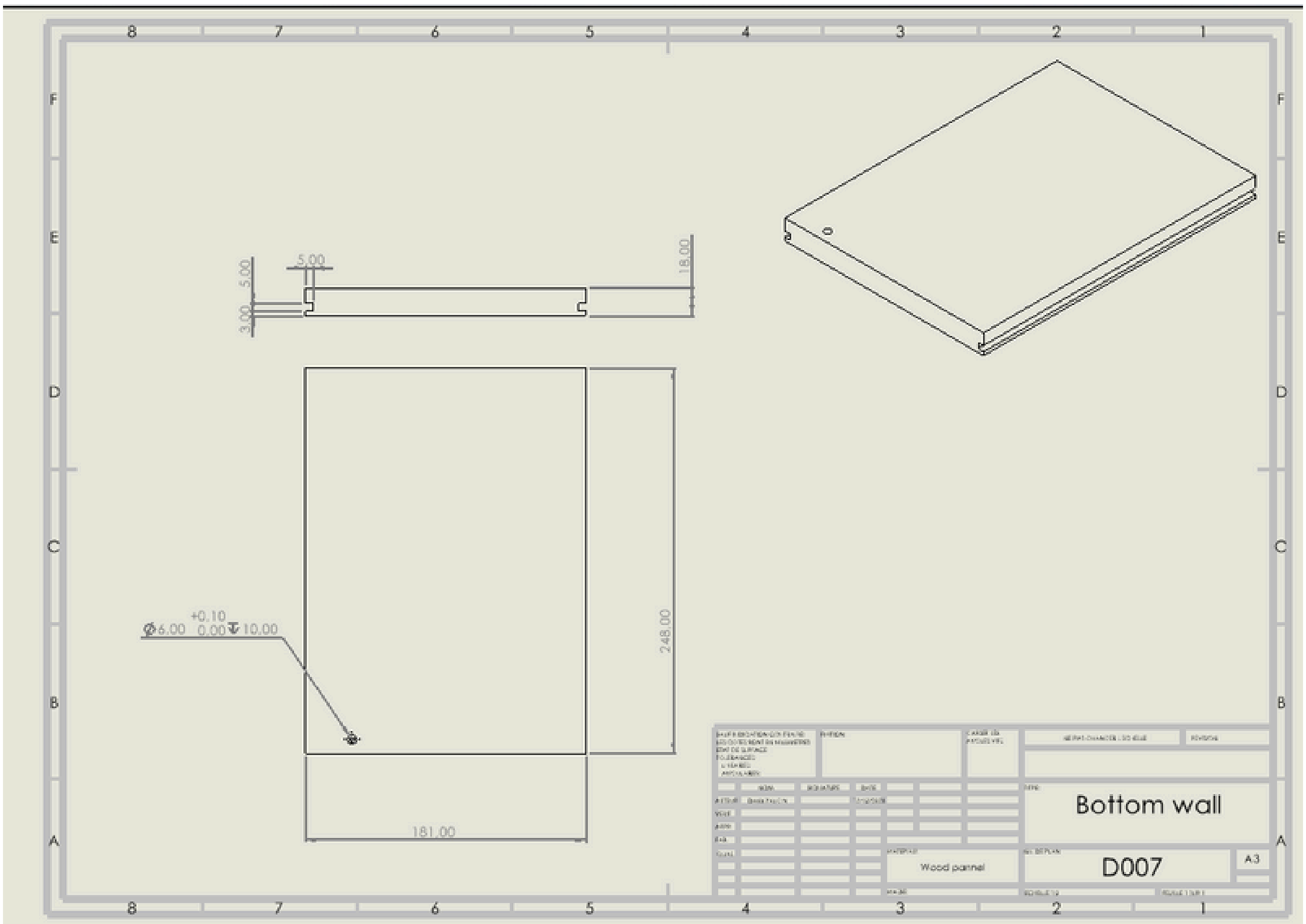
Part number : D006 - Roof Left
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wooden material to a board of 266 mm x 160 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D006_Detail_Drawing
2	60'	Drill the 4 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D006_Detail_Drawing
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D006_Detail_Drawing
4	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D006_Detail_Drawing



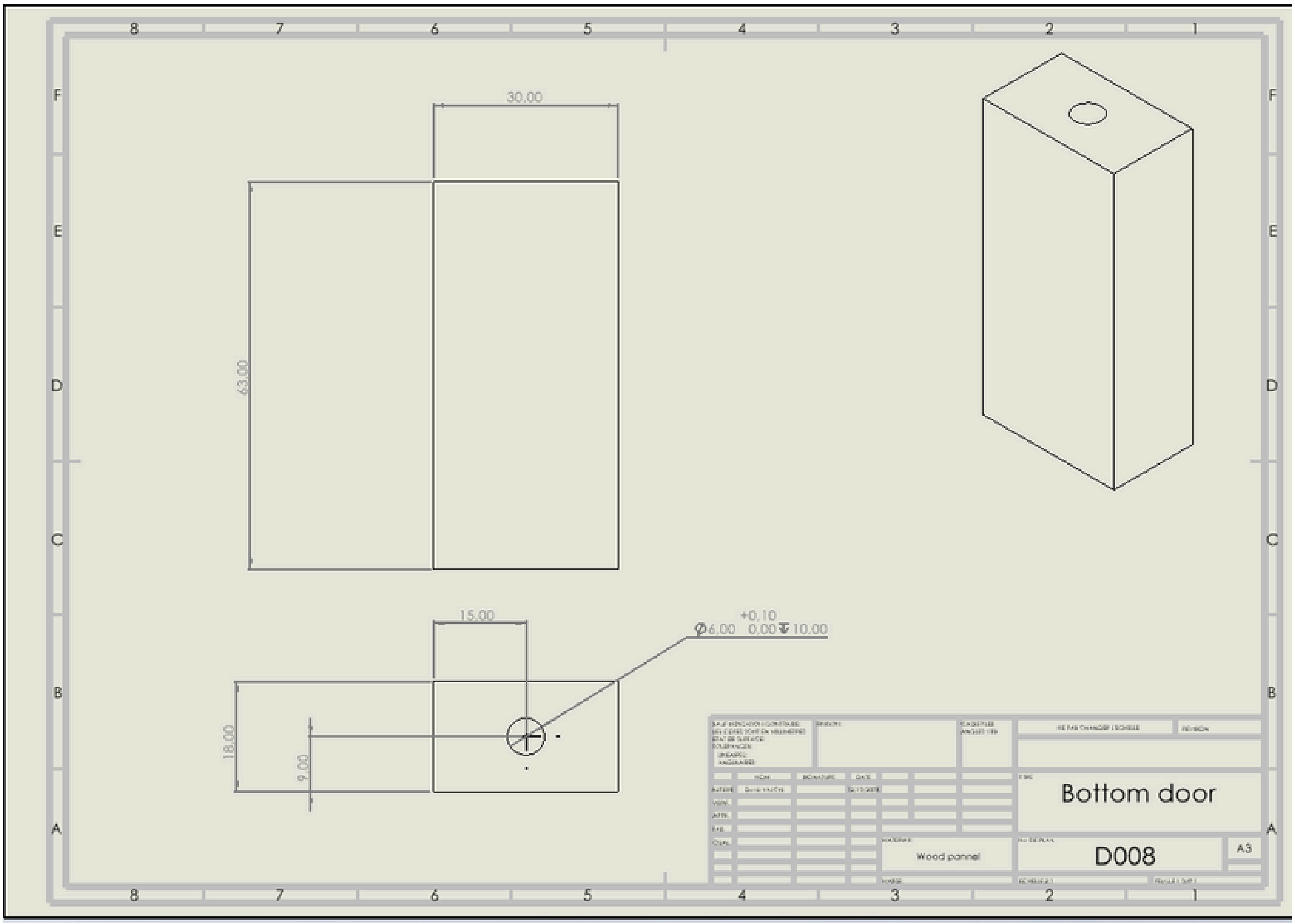
Part number : D007 - Bottom Wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wood panel to a board of 266 mm x 181 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D007_Detail_Drawing
2	60'	Drill a circular hole of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D007_Detail_Drawing
2	60'	Machine the slot to a depth of 5mm as seen on the detail drawing.	lab02 milling machine	End mill (suitable for wood)	1 operator	D007_Detail_Drawing and machining program.
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D007_Detail_Drawing
54	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D007_Detail_Drawing



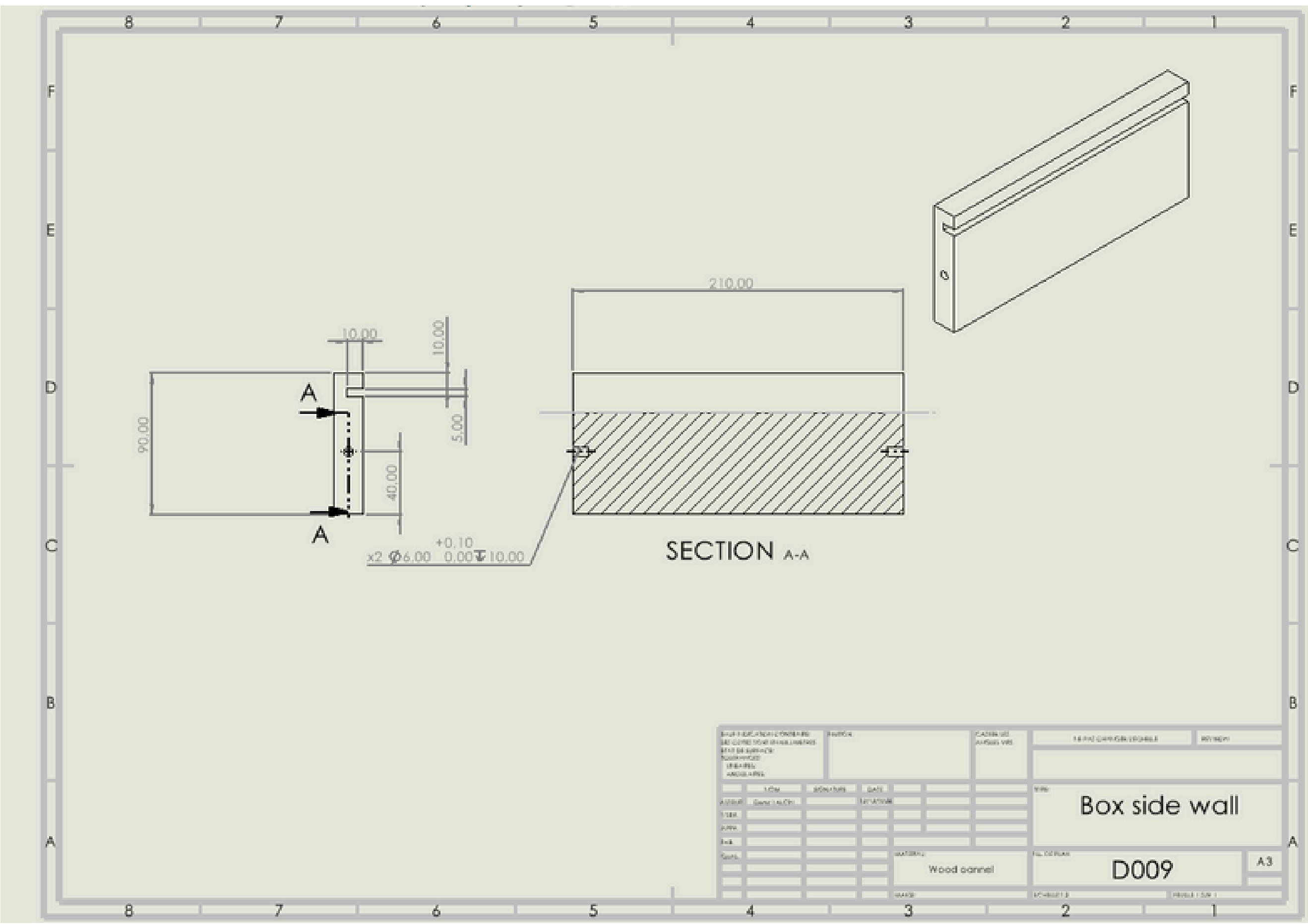
Part number : D008 - Bottom Door
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wood panel to a board of 63 mm x 30 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D008_Detail_Drawing
2	60'	Drill a circular hole of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D008_Detail_Drawing
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D008_Detail_Drawing
54	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D008_Detail_Drawing



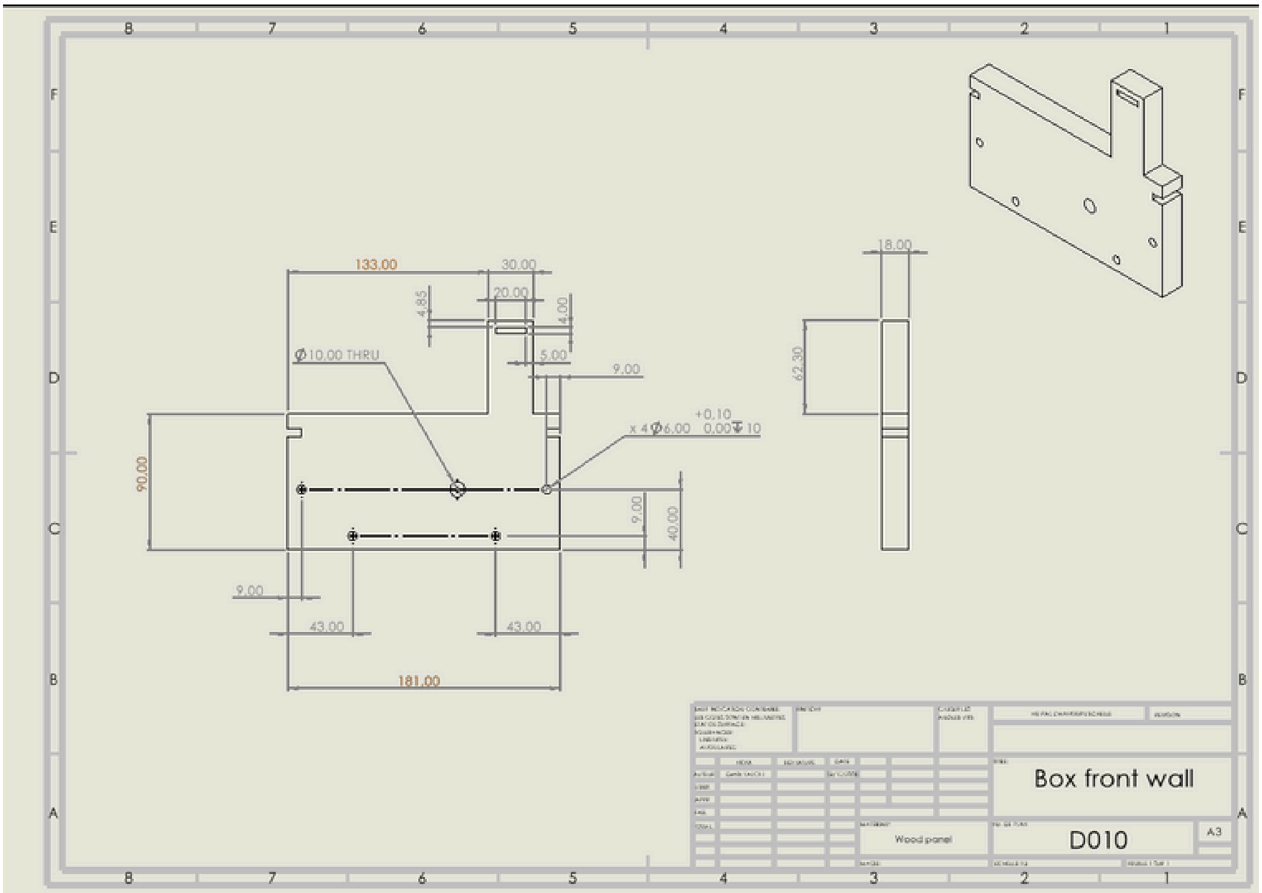
Part number : D009 - Box side wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60’	Cut the wood panel to a board of 290 mm x 90 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D009_Detail_Drawing
2	60’	Drill the 2 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D009_Detail_Drawing
3	60’	Machine the slot to a depth of 10mm	lab02 milling machine	End mill (suitable for wood)	1 operator	D009_Detail_Drawing and machining program.
4	60’	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D009_Detail_Drawing
5	60’	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D009_Detail_Drawing



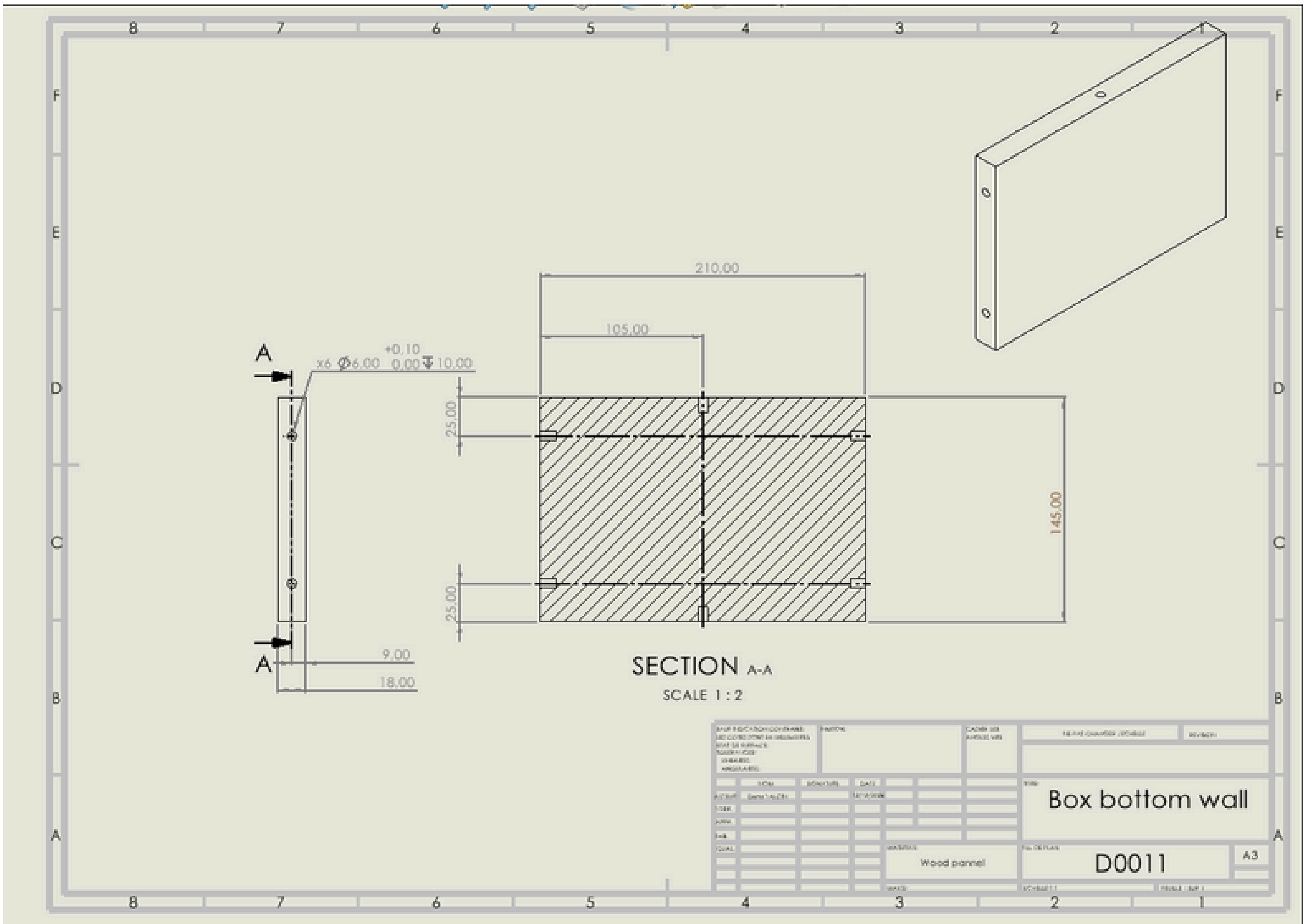
Part number : D010 - Box front wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60’	Cut the wood panel to a board of 152 mm x 181 mm and then cut again in order to make the form needed as shown in the detail drawing.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D010_Detail_Drawing
2	60’	Drill the 4 circular holes of diameter 6mm at the specified location to a depth of 10mm. Then drill a 10 mm hole.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D010_Detail_Drawing
3	60’	Machine the slots to a depth of 10mm and also the small opening.	lab02 milling machine	End mill (suitable for wood)	1 operator	D010_Detail_Drawing and machining programm.
4	60’	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D010_Detail_Drawing
5	60’	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D010_Detail_Drawing



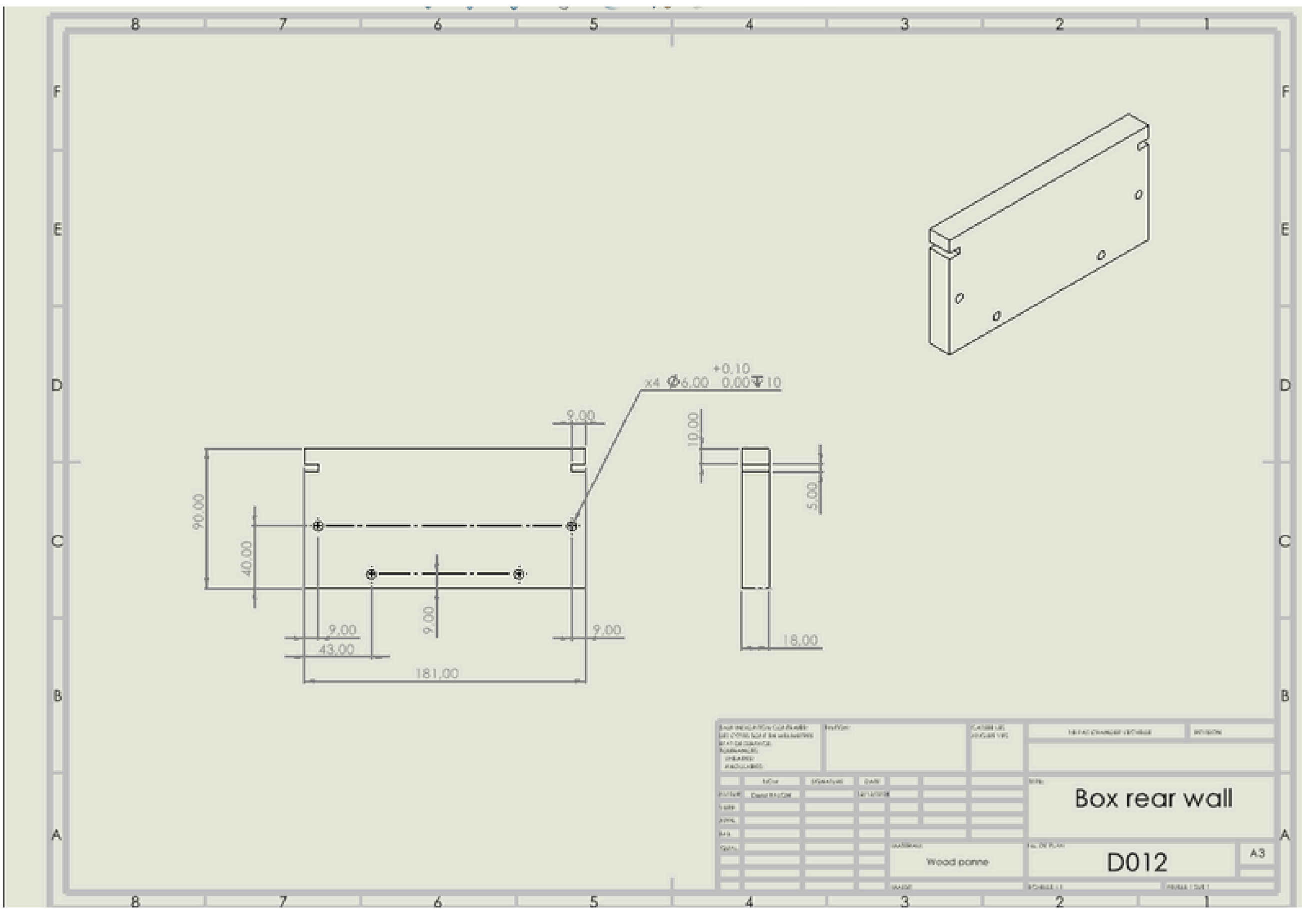
Part number : D011 - Box bottom wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wood panel to a board of 210 mm x 145 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D011_Detail_Drawing
2	60'	Drill the 6 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D011_Detail_Drawing
3	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D011_Detail_Drawing
4	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D011_Detail_Drawing



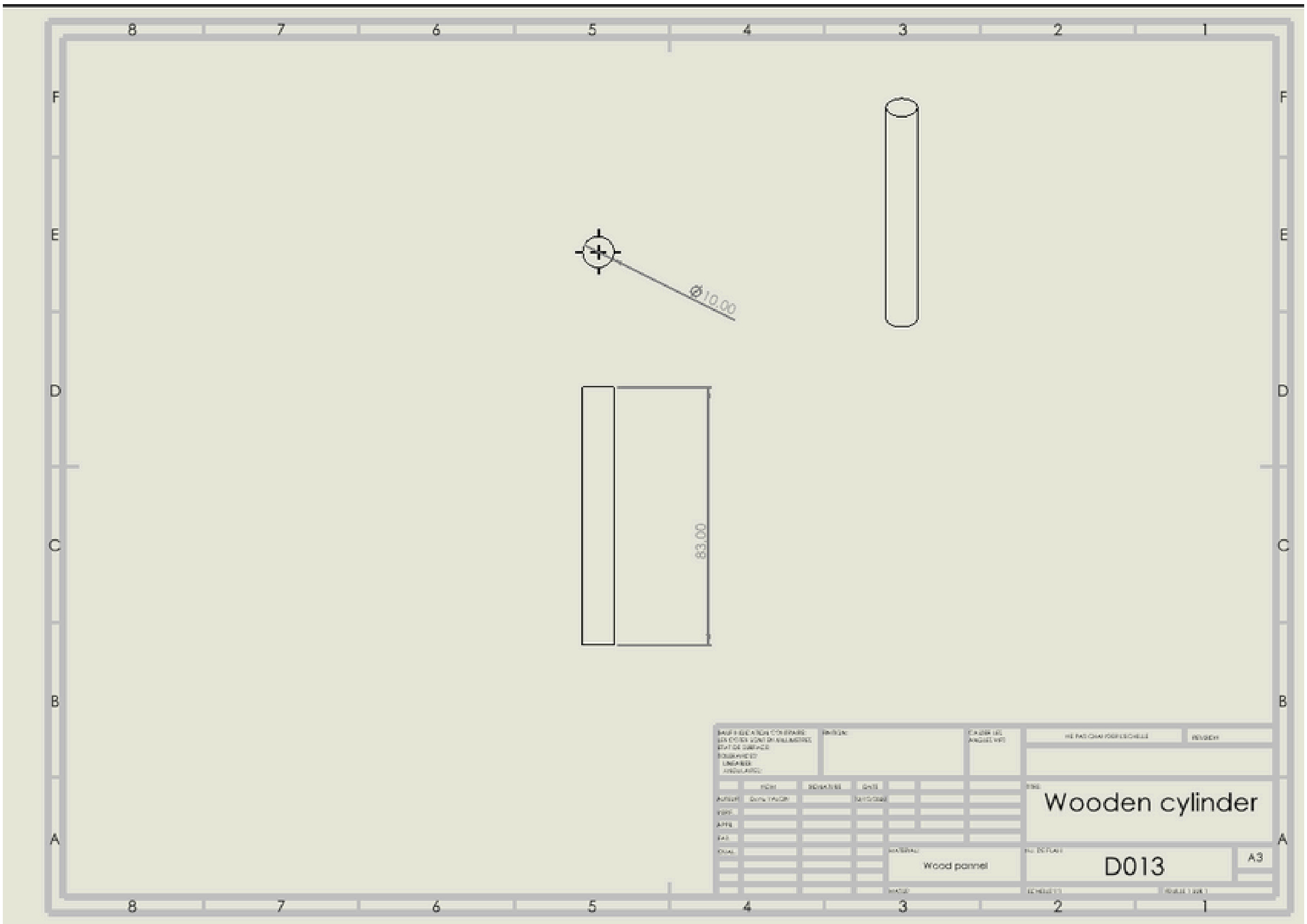
Part number : D012 - Box rear wall
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60’	Cut the wood panel to a board of 181 mm x 90 mm.	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D012_Detail_Drawing
2	60’	Drill the 4 circular holes of diameter 6mm at the specified location to a depth of 10mm.	Fablab drilling machine	Drill bits (for wood)	Accredited Fablab member or Fablab manager. 1 operator	D012_Detail_Drawing
3	60’	Machine the slots to a depth of 10mm.	lab02 milling machine	End mill (suitable for wood)	1 operator	D012_Detail_Drawing and machining programm.
4	60’	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D012_Detail_Drawing
5	60’	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D012_Detail_Drawing



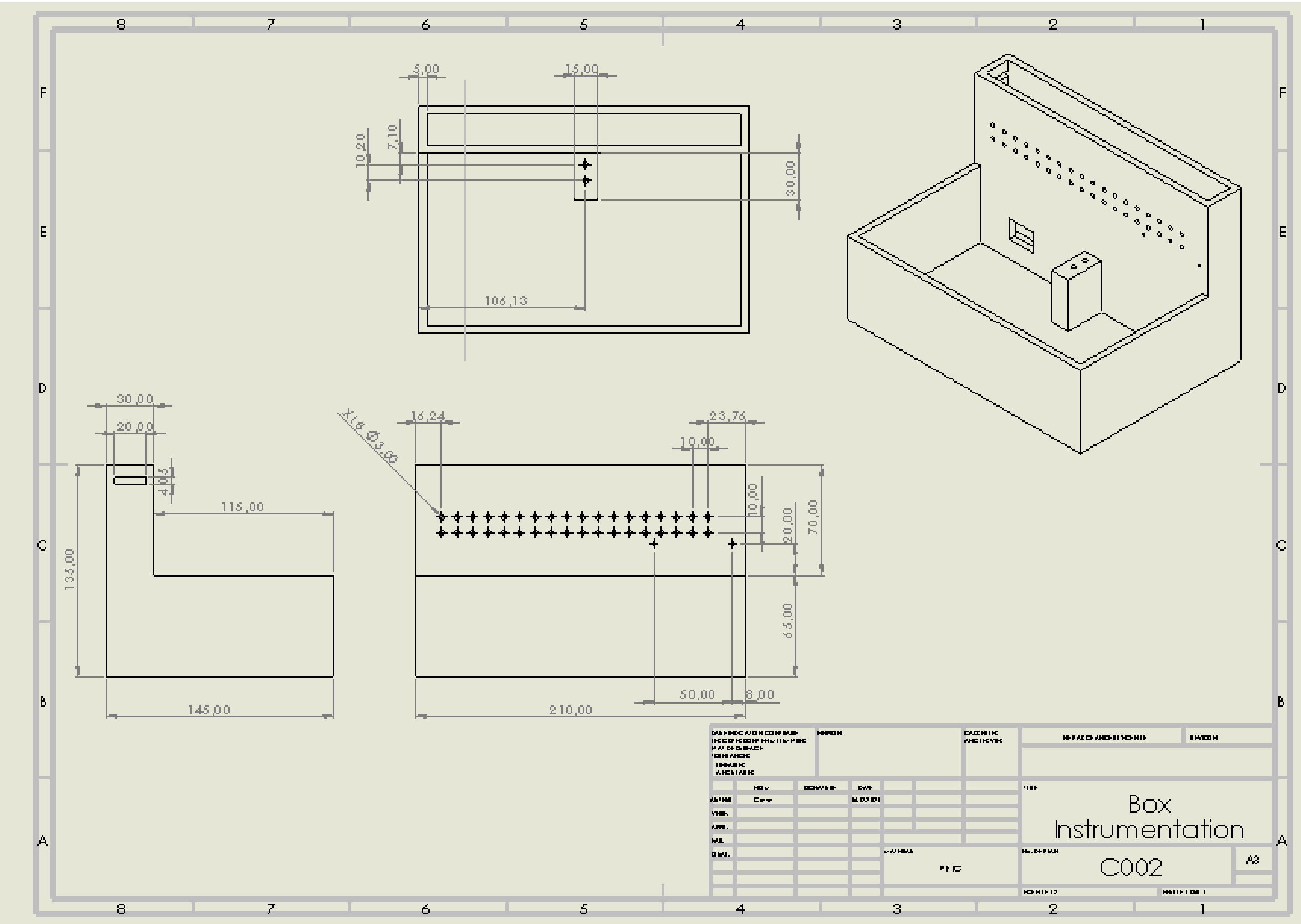
Part number : D013- Wooden cylinder
Raw material : D001 - *Wood panels 200cm x 30cm x 18mm*

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	60'	Cut the wood panel to a board of 83mm x 18 mm	Fablab bench saw	Wood blades and measuring tools (ruler, square).	Accredited Fablab member or Fablab manager. 1 operator	D012_Detail_Drawing
3	60'	Machine the the parallélépipède to form a cylinder.	lab02 milling machine	End mill (suitable for wood)	1 operator	D012_Detail_Drawing and machining programm.
4	60'	Smooth and refine the edges, ensuring no splinters remain. Sandpaper or chamfer manually.	Fablab	Sandpaper	1 operator	D012_Detail_Drawing
5	60'	Inspect all dimensions and check surface quality for accuracy	Fablab	Measuring tools	1 operator	D012_Detail_Drawing



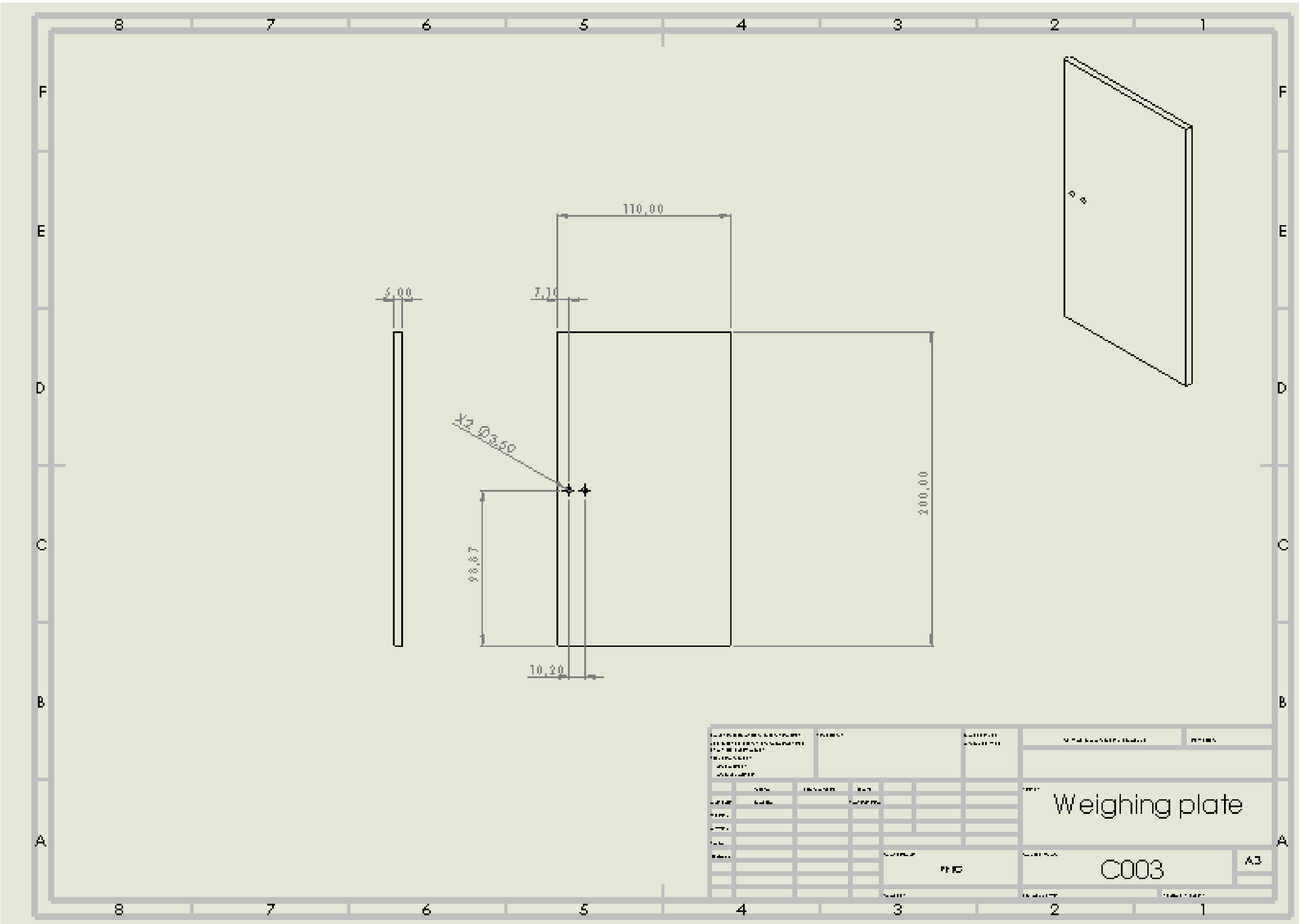
Part number : C002- Box Instrumentation
Raw material : C001 - PETG Filament - 1Kg

Step	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	1j 1h 24min	Print the Box Instrumentation	Fablab PRUSA 3D Printer	731,05 g PETG filament	Accredited Fablab member or Fablab manager. 1 operator	Box_Instrumentation.slt
2	10'	Pull off the print from the printer plate	Fablab	Prusa Spatula	Accredited Fablab member or Fablab manager. 1 operator	Box_Instrumentation.slt
3	60'	Remove all the imperfections from the printing	Fablab	Thin blade+Sandpaper	1 operator	Box_Instrumentation.slt



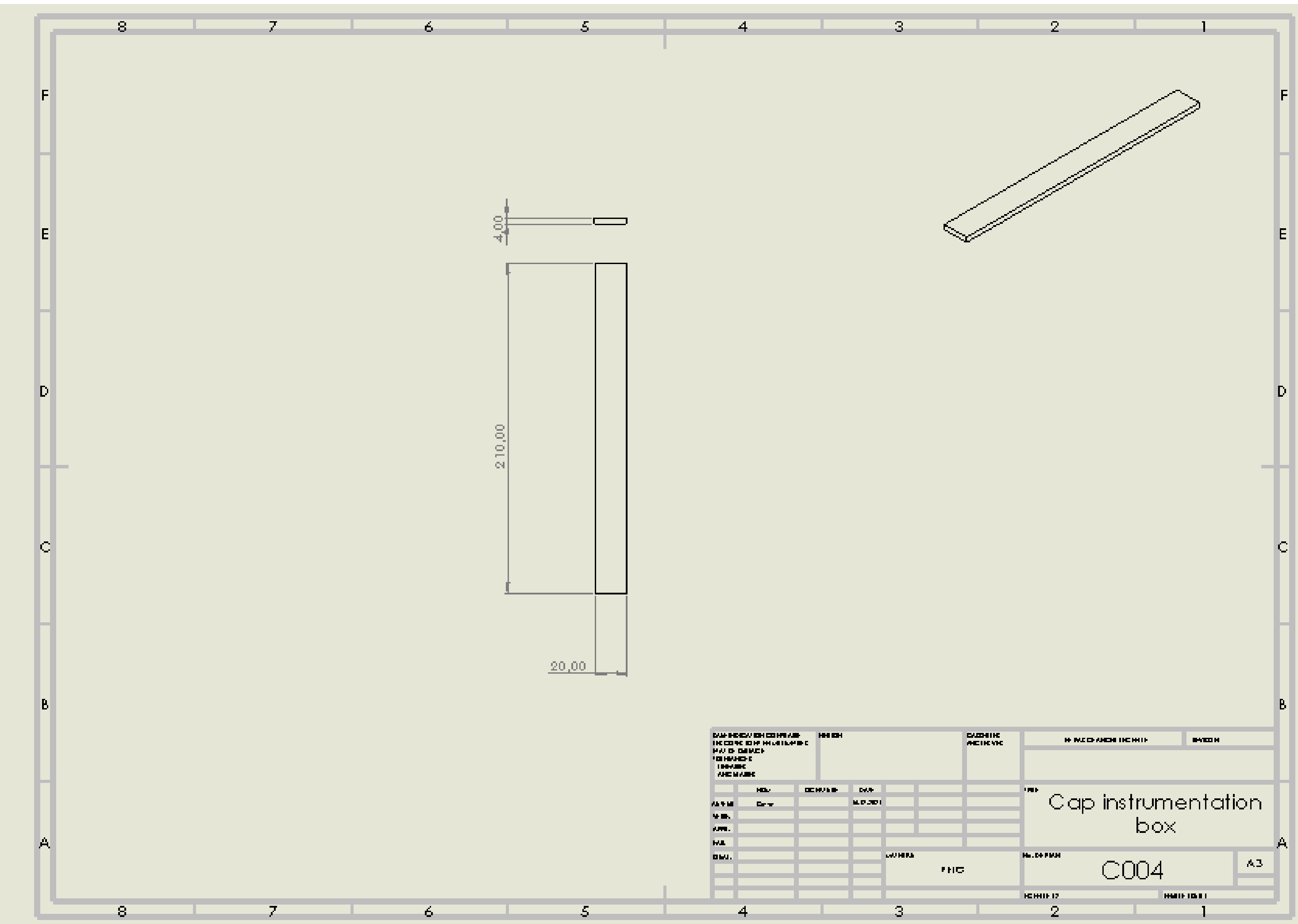
Part number : C003- Weighing plate
Raw material : C001 - PETG Filament - 1Kg

Ste p	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	8400' (2h20)	Print the Weighing plate	Fablab PRUSA 3D Printer	140,46 g PETG filament	Accredited Fablab member or Fablab manager. 1 operator	Weighing_plat e.slt
2	10'	Pull off the print from the printer plate	Fablab PRUSA 3D Printer	Prusa Spatula	Accredited Fablab member or Fablab manager. 1 operator	Weighing_plat e.slt
3	60'	Remove all the imperfections from the printing	Fablab	Thin blade+San dpaper	1 operator	Weighing_plat e.slt



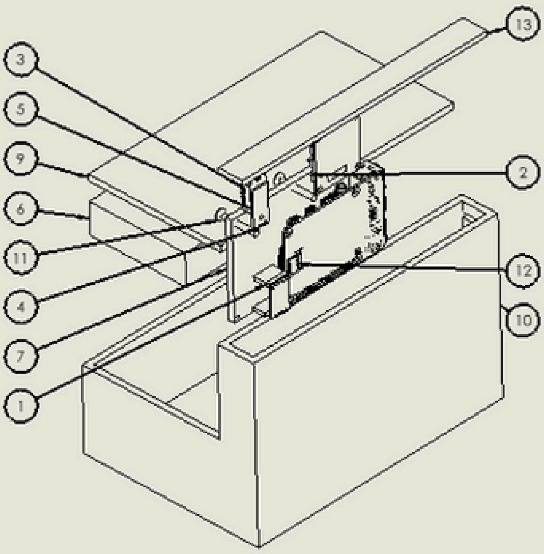
Part number : C004- Cap Instrumentation box
Raw material : C001 - PETG Filament - 1Kg

Ste p	Duration	Description	Equipment	Tools	Ressources	Document & Input
1	56 min	Print the Cap Instrumentation box	Fablab PRUSA 3D Printer	21,98g PETG filament	Accredited Fablab member or Fablab manager. 1 operator	Cap_Instrumentation_box.slt
2	10'	Pull off the print from the printer plate	Fablab PRUSA 3D Printer	Prusa Spatula	Accredited Fablab member or Fablab manager. 1 operator	Cap_Instrumentation_box.slt
3	60'	Remove all the imperfections from the printing	Fablab	Thin blade+Sandpaper	1 operator	Cap_Instrumentation_box.slt



E.2 Instrumentation system assembly procedure

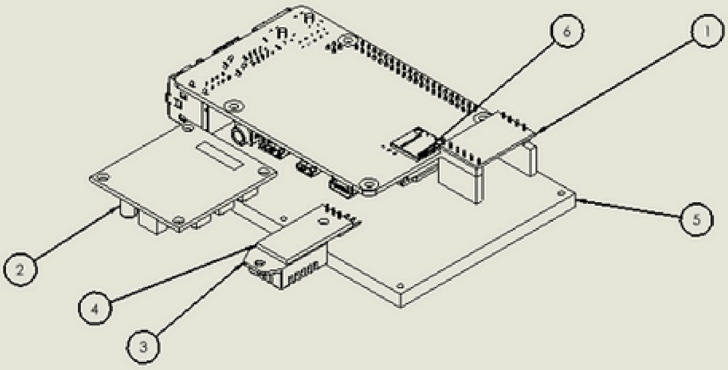
ASSEMBLY PLAN OF THE INSTRUMENTATION SYSTEM



No. ARTICLE	NUMERO DE PIECE	QTE
1	HX711	1
2	ISD1820.step	1
3	dht22_1.step	1
4	Right angle 3 pin header.step	1
5	DHT22 Module.step	1
6	Battery	1
7	PCBModelV1	1
8	Load cell 5Kg_2.stp	1
9	Scale	1
10	Box_instrumentation	1
11	B18.6.7M - M4 x 0.7 x 30 Type I Cross Recessed FHMS -- 30N	2
12	Raspberry Pi 4 Model B	1
13	cap_instrumentation Box	1
14	B18.6.7M - M3 x 0.7 x 30 Type I Cross Recessed FHMS -- 30N	3

Instrumentation_System

ASSEMBLY PLAN OF THE PCB

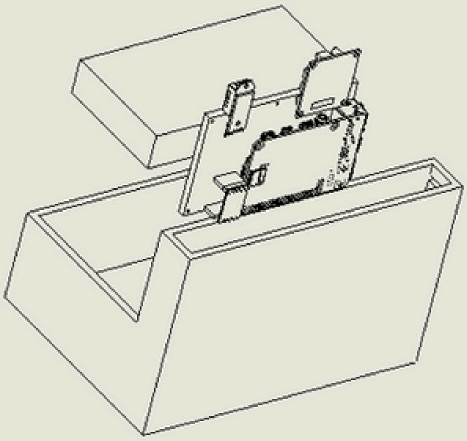


No. ARTICLE	NUMERO DE PIECE	QTE
1	HX711	1
2	ISD1820.step	1
3	dht22_1.step	1
4	DHT22 Module.step	1
5	PCBModelV1	1
6	Raspberry Pi 4 Model B	1

Draw1

ASSEMBLY PLAN OF THE INSTRUMENTATION SYSTEM

1st step



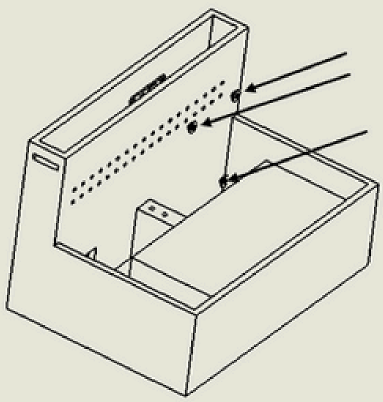
No. ARTICLE	NUMERO DE PIECE	QTE
1	HX711	1
2	ISD1820.step	1
3	dht22_1.step	1
4	Right angle 3 pin header.step	1
5	DHT22 Module.step	1
6	Battery	1
7	PCBModelV1	1
10	Box_instrumentation	1
12	Raspberry Pi 4 Model B	1

Place the Assmebly of the PCB at the bottom of the pocket.
Place the Battery at the bottom as shown

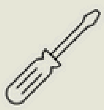
Instrumentation_System

ASSEMBLY PLAN OF THE INSTRUMENTATION SYSTEM

2nd step



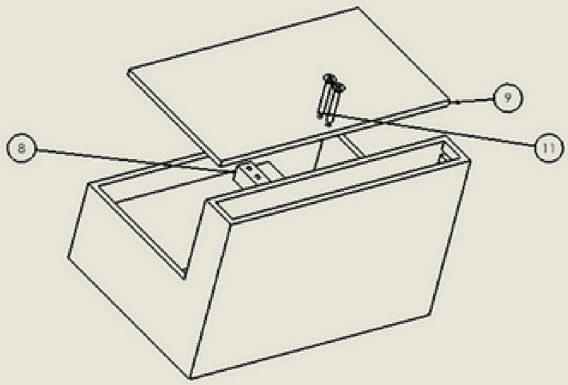
No. ARTICLE	NUMERO DE PIECE	QTE
14	B18.6.7M - M3 x 0.7 x 30 Type I Cross Recessed FHMS -- 30N	3



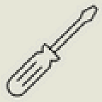
Use a screw driver

ASSEMBLY PLAN OF THE INSTRUMENTATION SYSTEM

3rd step



No. ARTICLE	NUMERO DE PIECE	QTE
8	Load cell 5Kg_2.stp	1
9	Scale	1
11	B18.6.7M - M4 x 0.7 x 30 Type I Cross Recessed FHMS -- 30N	2

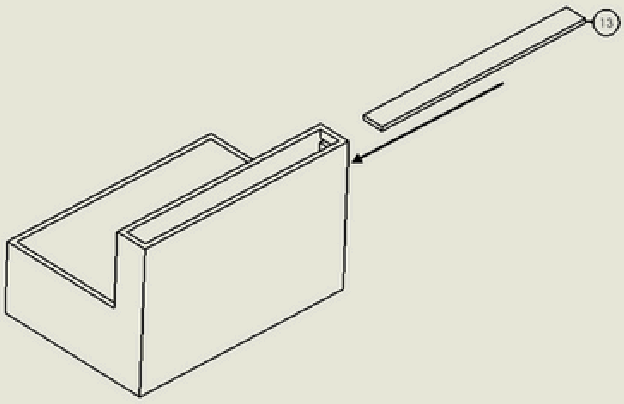


Use a screw driver

A3

ASSEMBLY PLAN OF THE INSTRUMENTATION SYSTEM

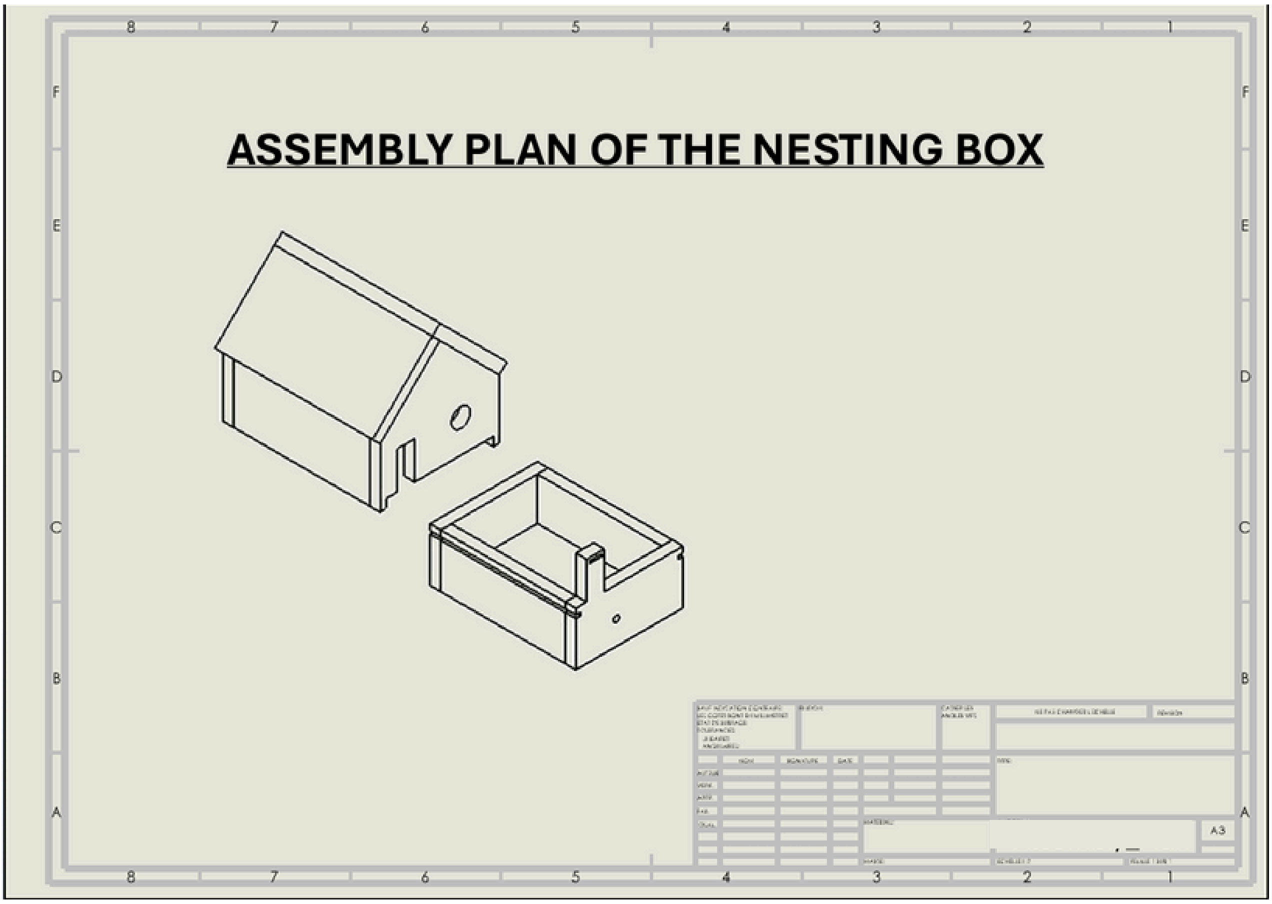
Final step

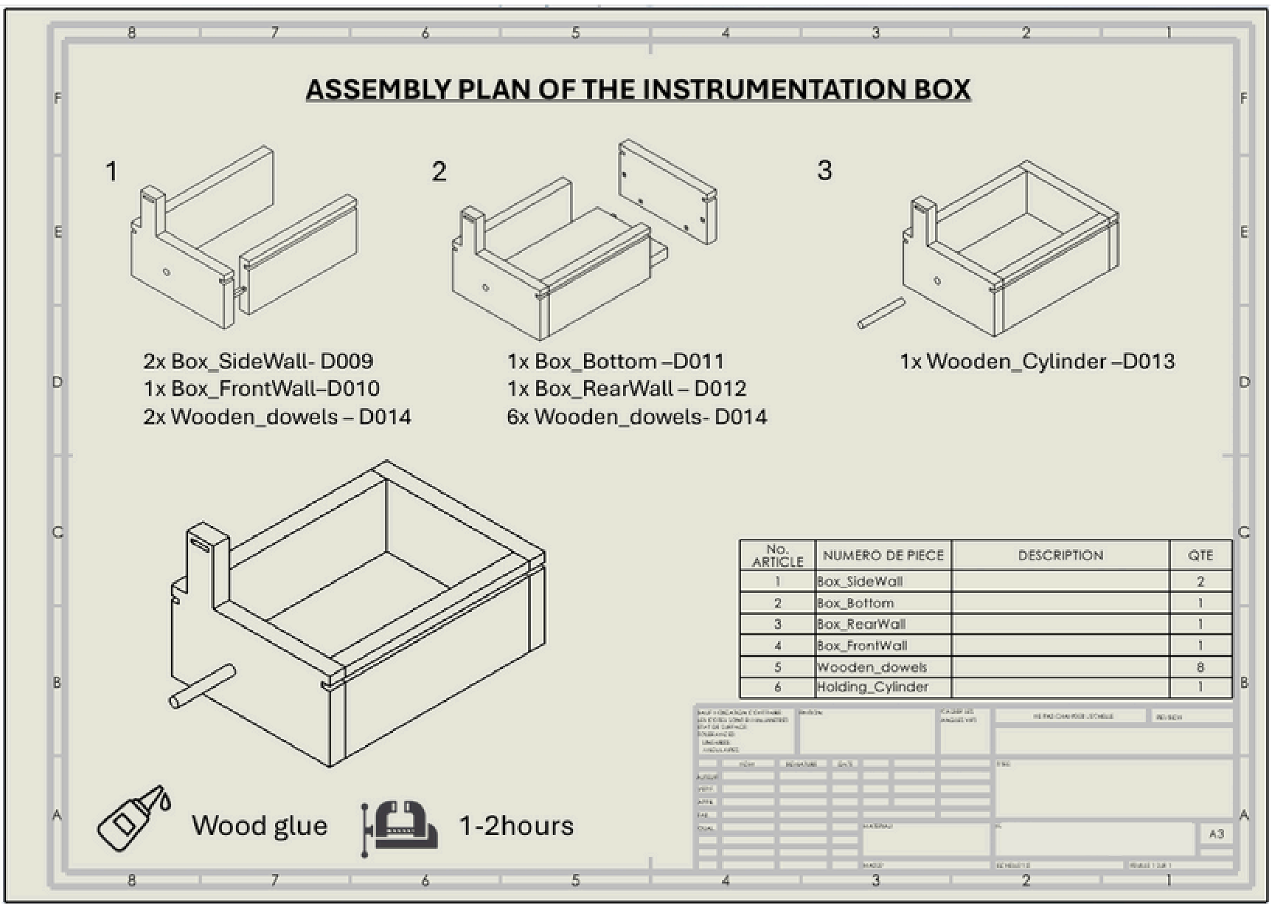


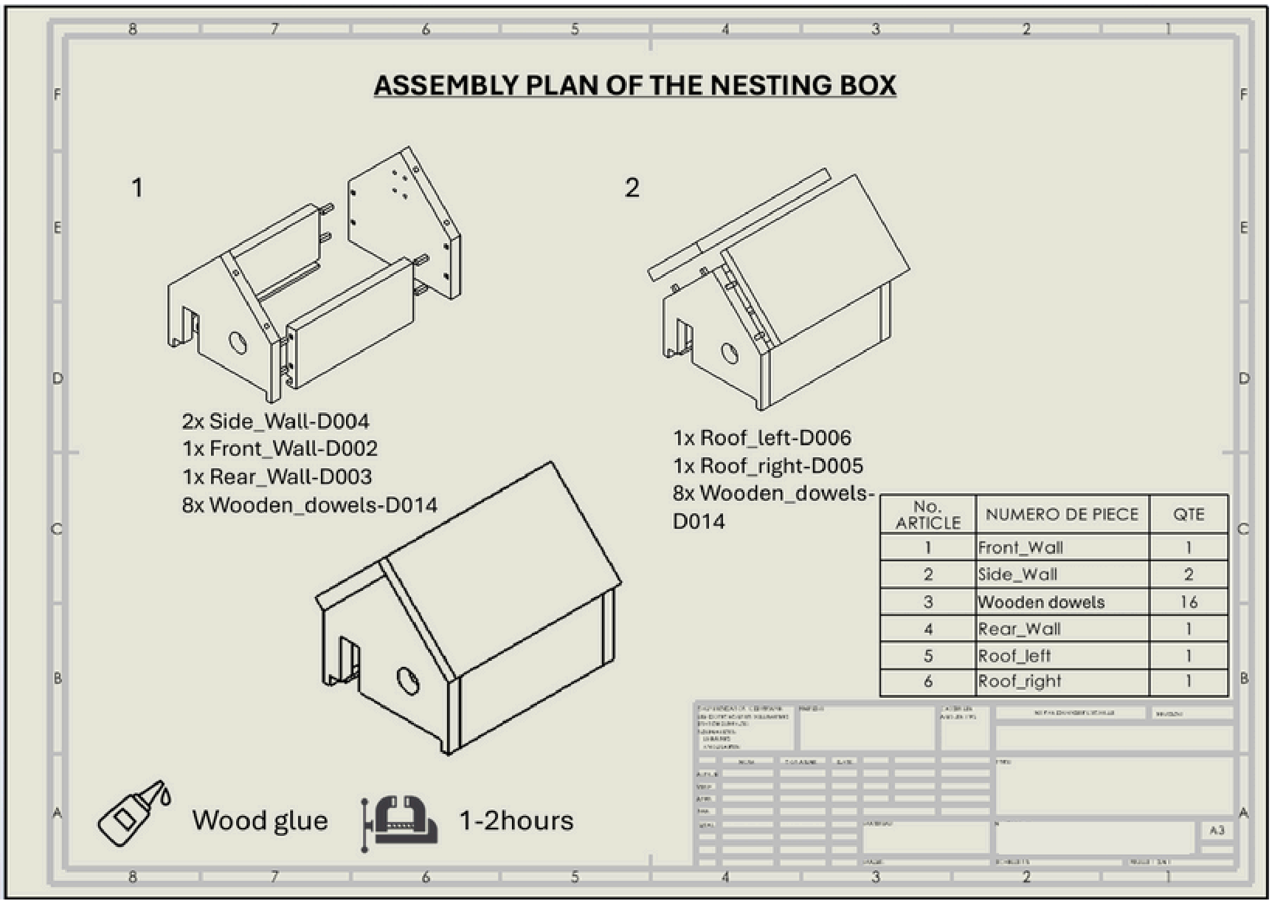
No. ARTICLE	NUMERO DE PIECE	QTE
13	cap_instrumentation Box	1

A3

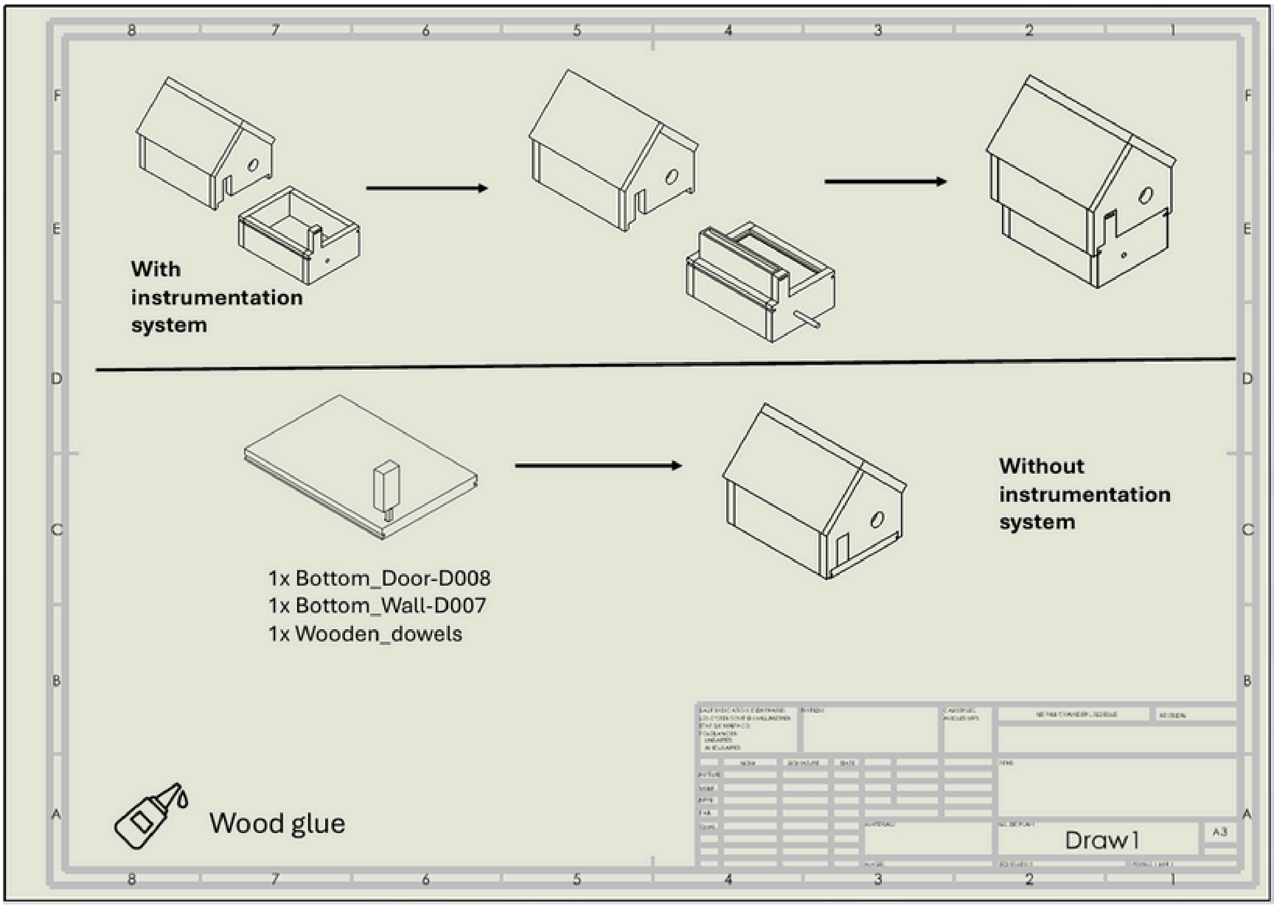
E.3 Nesting box assembly procedure







No. ARTICLE	NUMERO DE PIECE	QTE
1	Front_Wall	1
2	Side_Wall	2
3	Wooden dowels	16
4	Rear_Wall	1
5	Roof_left	1
6	Roof_right	1



F. Risk Analysis

By using the provided risk analysis template, we can anticipate potential issues and categorize them based on their severity and likelihood of occurrence. This enables us to identify appropriate solutions to either prevent these issues or minimize their impact.

This table includes various lifecycles addressing a range of potential issues. Here are some interesting choices:

Assembly

Situation	Global Risk Level	Risk mitigation action	Global Risk Level
Tolerances are not precise enough, and the birdhouse does not hold properly.	9	Provide tool usage training and safety instructions.	3

Transport

Situation	Global Risk Level	Risk mitigation action	Global Risk Level
The instrumentation system must be moved, causing potential cable disconnections.	9	Place the entire system in a drawer to avoid disconnections.	2

Installation

Situation	Global Risk Level	Risk mitigation action	Global Risk Level
Handling or carrying birdhouse components manually.	6	Use lifting aids and ergonomic tools to reduce strain.	3

Lifting/Handling

Situation	Global Risk Level	Risk mitigation action	Global Risk Level
Moving the birdhouse during assembly or transport.	9	Use proper lifting techniques and a second person for assistance.	3

Project Management

Situation	Global Risk Level	Risk mitigation action	Global Risk Level
Partner fails to meet deadlines	12	Add time buffers to the schedule and have a catch-up plan	8

To view the full document, please refer to the screenshot below :

Hazard Identification			Risk assesment		
Lifecycle	**Situation**	**Hazard description**	**Probability**	**Severity**	**Global Risk Level**
Assembly	Assembling birdhouse components.	Risk of injury due to improper method.	2 - Unlikely	2 - Low	4
Assembly	Tolerances are not precise enough, and the birdhouse does not hold properly.	Instability of the birdhouse structure due to poor tolerances.	3 - Likely	3 - Medium	9
Commissionning	Testing sensors and connected features.	Risk of electrical shock or malfunction.	2 - Unlikely	3 - Medium	6
Commissionning	The instrumentation system is faulty, and the microphone receives noise.	Unclean audio data due to excessive noise interference.	3 - Likely	3 - Medium	9
Transport	The instrumentation system must be moved, causing potential cable disconnections.	Accidental disconnection of cables during transport.	3 - Likely	3 - Medium	9
Transport	Moving the birdhouse to the installation site.	Risk of damage to the birdhouse.	3 - Likely	2 - Low	6
Installation	The installation process might seem complex at first glance.	Users struggle with the complexity of installation.	2 - Unlikely	2 - Low	4
Installation	Mounting the birdhouse	Risk of falling birdhouse during installation	2 - Unlikely	3 - Medium	6
Installation	Handling or carrying birdhouse components manually.	Risk of injury or strain during manual handling.	2 - Unlikely	3 - Medium	6
Maintenance	Cleaning the birdhouse.	Risk of injury from sharp components or falling.	3 - Likely	3 - Medium	9
Maintenance	Difficult access to the instrumentation system and birdhouse interior.	Limited accessibility for maintenance operations.	3 - Likely	3 - Medium	9
Lifting/Handling	Moving the birdhouse during assembly or transport.	Risk of back strain or dropping the birdhouse.	3 - Likely	3 - Medium	9
Operation	Birdhouse is in use by wildlife.	Risk of overheating or component failure.	2 - Unlikely	4- High	8
Operation	Sensors or components may be affected by wildlife interference.	Sensors or components may get obstructed or damaged by wildlife.	3 - Likely	3 - Medium	9
Dismantling	Removing the birdhouse at the end of its lifecycle.	Risk of injury from loose or degraded components.	2 - Unlikely	3 - Medium	6
Project management	A team member gets injured while skiing	Temporary inability of the member to contribute	3 - Likely	3 - Medium	9
Project management	Partner fails to meet deadlines	Delays the overall project timeline	3 - Likely	4- High	12

Risk mitigation	Risk assesment after mitigation			Detailed information
Risk mitigation action	**Probability**	**Severity**	**Global Risk Level**	
Provide tool usage training and safety instructions.	1 - Very unlikely	2 - Low	2	Use ergonomic method and gloves to prevent injuries.
Use wood glue to compensate for imprecise tolerances.	1 - Very unlik...	3 - Medium	3	Ensure accurate dimensions during production to reduce assembly complexity.
Conduct pre-installation electrical tests and label high-voltage areas.	1 - Very unlikely	3 - Medium	3	Test with insulated gloves and use surge protection.
Add acoustic foam to the microphone.	2 - Unlikely	3 - Medium	6	Test audio input in various conditions to validate improvements.
Place the entire system in a drawer to avoid disconnections.	1 - Very unlik...	3 - Medium	3	Secure cables within the drawer and provide labeling for reconnections.
Use protective packaging and secure the birdhouse during transport.	1 - Very unlikely	2 - Low	2	Use bubble wrap or foam padding.
Provide a step-by-step installation manual.	1 - Very unlik...	2 - Low	2	Include diagrams and simplified instructions in the manual.
Provide detailed instructions, ensure screws are tightened properly, and include safety warnings	1 - Very unlikely	3 - Medium	3	Use strong and weatherproof materials for mounting, such as stainless steel screws
Use lifting aids and ergonomic tools to reduce strain.	1 - Very unlik...	3 - Medium	3	Provide clear lifting protocols for handlers.
Provide a maintenance manual and tools to avoid accidents.	1 - Very unlikely	3 - Medium	3	Use removable panels for safe cleaning access.
Install a sliding drawer for the system and an opening roof for the birdhouse.	1 - Very unlik...	3 - Medium	3	Regularly inspect the sliding drawer and roof opening for wear and tear.
Use proper lifting techniques and a second person for assistance.	1 - Very unlikely	3 - Medium	3	Provide straps or handles for easier lifting.
Use temperature-resistant materials and sensors with auto-shutdown.	1 - Very unlikely	4- High	4	Regularly monitor for maintenance needs.
Design protective casings and implement animal-safe deterrents for sensors.	2 - Unlikely	4- High	8	Inspect sensors periodically and clean casings as needed.
Inspect all components before dismantling and wear protective gear.	1 - Very unlikely	3 - Medium	3	Use step-by-step dismantling instructions.
Assign a temporary replacement and reorganize priority tasks	2 - Unlikely	3 - Medium	6	Establish a contingency plan in case of prolonged absence.
Add time buffers to the schedule and have a catch-up plan	2 - Unlikely	4- High	8	Establish regular checkpoints to monitor progress and adjust accordingly.

G. Planning & product qualification program

H.1 Matrice RACI

We chose to use a RACI matrix to clearly define and visualize the roles and responsibilities of each team member for every task. This tool helps us avoid confusion by showing who is responsible, accountable, consulted, and informed for each activity. It also ensures that tasks are well-distributed, prevents overlapping efforts, and provides a clear overview of everyone's workload, allowing us to stay organized and efficient throughout the project.

Task / Stakeholders	Deniz	Axel	Andréas	Joséphine	Turko
Detail drawing of all manufactured part	R	A	I	A	C
Wiring diagrams	I	R	I	I	C
Software Algorithms	I	R	A	I	C
Updated CAO	R	I	I	I	C
Calculation or simulation results	A	I	I	R	C
Manufacturing and assembly procedure	R	A	A	R	C
Risk Analysis	I	I	R	A	C
Planning & product qualification program	I	I	R	A	C

Responsible Who is responsible for executing the task ?	**Accountable** Who is accountable for the completion of each task ?
Consulted Who needs to provide their input or expertise to the task ?	**Informed** Who needs to stay informed and up-to-date on the progress of a task ?

H.2 Planning Update

We decided to use Notion to structure and manage our project efficiently, because every team member is familiar with the tool. Notion gives us an **easy-to-use visual interface**, which helps us **plan the different milestones and assign tasks to each member**. By **adding deadlines to each task**, we can track our progress in real time and quickly see if we are meeting deadlines or falling behind.

Milestone 4 : Technical file 7

Nom	Status	Personne	Deadline
Risk analysis	Terminé	Andreas Adain	November 29, 2024
Wiring diagrams	Terminé	Axel Marsacq	December 2, 2024
Details and assembly drawing	En cours	Deniz YALCIN	December 8, 2024
Routing of all parts	En cours	Joséphine Cottin	December 11, 2024
Software algorithm	Terminé	Axel Marsacq	December 13, 2024
Calculation and simulation results	En cours	Joséphine Cottin	December 13, 2024
Product qualification planning	En cours	Andreas Adain	December 14, 2024
+ New page			

Milestone 5 : Sub-assembly Qualification 3

Nom	Status	Personne	Deadline
Presentation of a first part of the prototype aiming to demonstrate that a success factor identified in technical file has been tested.	Pas comme...		
Update of the technical file	Pas comme...		
Update of the product qualification	Pas comme...		
+ New page			

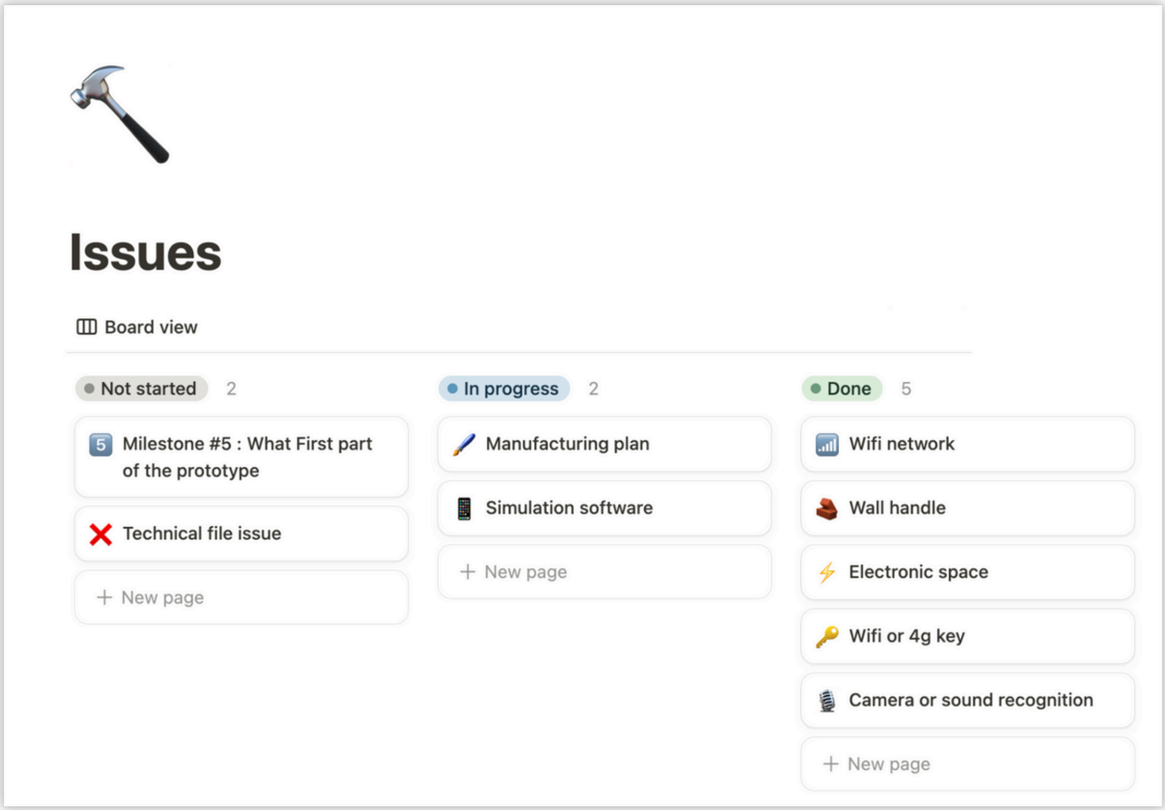
We decided to use Notion to structure and manage our project efficiently, because every team member is familiar with the tool. Notion gives us an easy-to-use visual interface, which helps us plan the different milestones and assign tasks to each member. By adding deadlines to each task, we can track our progress in real time and quickly see if we are meeting deadlines or falling behind.

To make our organization even better, we added some improvements, **like a RACI matrix**. This matrix helps us clearly see each member's responsibilities, their role in each task, and the overall workload. We also created a dedicated **"Issues" section**. **This section allows us to identify technological obstacles and document them so we can solve them in a structured and efficient way.**

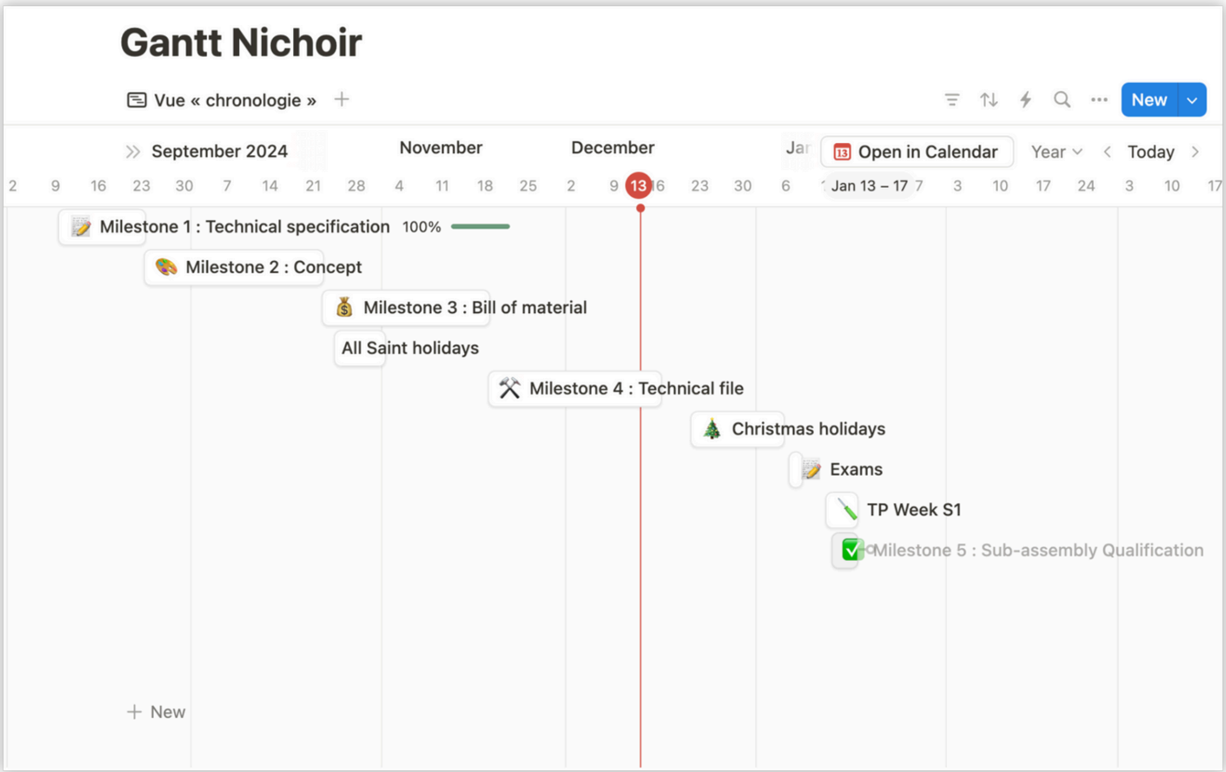
One example of how we use this section is when we worked on the Bill of Materials (BOM). Several technical questions came up during this step, including:

- How can we hang the birdhouse at a height and make sure it's stable ?
- Where should we place it, and do we have permission to attach it to a wall at the school ?
- For our Wi-Fi-based system, how far can the signal reach ? Is there a nearby tree, and can we attach the birdhouse there ?

By adding these questions to our "Issues" section, we were able to **prioritize the problems and solve the technical challenges** in a logical order. Each task was planned step by step to increase the chances of the project's success. At the same time, we updated the overall project schedule and the product qualification process, identifying the key points to present during milestone 5.



Lastly, using visual tools like the Gantt chart in Notion gives us a clear view of deadlines and project stages. This organized approach helps us move forward efficiently while ensuring consistency between all the phases, from technical specifications to sub-assembly qualification.



H.3 Product qualification program

1. Nesting box stability

- **High-wind simulation:** Test the stability of the nesting box by subjecting it to simulated gusts of wind (e.g. with a fan) to ensure that it stays in place.
- **Vibration tests:** Install the nesting box on different supports (trees, walls, posts) and apply vibrations simulating natural movements (wind or wildlife).
- **Installation stress test:** Check that fasteners can withstand forces equivalent to those generated by a bird or climatic conditions (snow, rain).

2. Wi-Fi connectivity

- **Range test:** Measure the maximum distance between the nesting box and the Wi-Fi router while maintaining a stable connection.
- **Obstacle simulation:** Test connectivity when there are obstacles (walls, trees) between the nesting box and the router.

3. Material resistance

- **Load test:** Apply a load equivalent to or greater than the weight of birds or small animals likely to approach the nesting box.

4. Protection of occupants (birds)

- **Predator safety:** Check that the design prevents access by predators such as cats or rodents.

5. Electronic system functionality

- **Sensor reliability:** Check sensor readings (temperature, humidity) to ensure they are accurate under different environmental conditions.
- **Fault simulation:** Temporarily disconnect certain components (Wi-Fi module, sensor) to assess how the system reacts to a fault.

Key Steps in the Qualification Process:

1. Identify the Elements to Test
We have selected essential points to verify based on the technical file. These include:

- Stability of the birdhouse: Ensuring it can be securely mounted and remains stable once installed.
- Wi-Fi connectivity: Checking that the signal is reliable and meets the required range.
- Material resistance: Testing whether the materials are strong enough to withstand external conditions.

2. Conduct Tests
Each element is tested to ensure it functions as intended, following the specifications outlined in the technical file.

Examples include:

- **Stability of the birdhouse:** Ensuring it can be securely mounted and remains stable once installed.
- **Wi-Fi connectivity**: Verifying the range and reliability of the signal to confirm proper system operation.
- **Material resistance:** Testing the durability of materials under environmental conditions, such as exposure to weather.

3. Document the Results in the Technical File
The test results and any issues encountered are recorded in the technical file. This ensures clear and up-to-date tracking of the project's progress.

4. Present Results for Milestone 5
The test results are summarized and presented during milestone 5. This demonstrates that the key elements have been validated and identifies areas for improvement.

5. Expected Outcome for Milestone 5
Through this process, we can verify that the essential components of the prototype function correctly. This approach helps us progress in an organized way and ensures the final product's reliability.