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STUDY OF POSSIBLE SOLUTIONS
FOR AN OUTSIDE BENCH

This project is prepared by Xavier Roman Sirera on summer semester of 2017, a part of design project lecture. The lecture is given by Ing. Rudolt Martonka Ph.D.

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ACKNOWLEDGEMENTS

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ACKNOWLEDGMENTS

This bachelor has been written at the Mechanical Engineering Faculty of Technical University of Liberec during the summer semester of 2017. This project is for the teacher Rudolf Martonka responsible the subject Project II

ABSTRACT

The aim of this project is to respond to a specific problem posed, in this case outside seating, with several possible options. For later, by means of criteria of classification and weight, choose the most suitable solution. There are two solutions: concept **A**, and concept **B**.

As a result of the criteria, it is done a study of the solution to be developed and all the processes necessary to materialize it.

1. PROBLEM DEFINITION

This document addresses the development of a project to develop a specific product for one or more specific uses. The document helps the rapid and efficient assimilation of each process.

It has been tried to find an aesthetic solution to the typical urban bench.

Some of the prerequisites:

- .A bench with enough space for two people
- .Resistant and light
- .Safety
- .Enduring, especially on the outside

LIST OF TABLE

Table number	Description
1	Criterion table
2	Activitys Table
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Image number	Description
1	Concept A
2	Concept B
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4	Systemic diagram
5	Planning of activities
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7	Structural Analysis

LIST OF DRAWINGS

Drawing number	Description
1	Plan set bench
2	Plan subset 2
3	Plan element 2.2
4	Plan element 2.1
5	Plan element 1.1

2. CONCEPT GENERATION AND SELECTION

There are many ways to develop a product and fulfill the desired functions. You can vary the shape, the materials, the assembly.

To do this, two possible solutions for an outside bench are presented. These solutions are studied through a table of functions and weights, resulting in the most viable solution to be developed.

As a result, the best option has been studied, and this study includes a list of specifications: technical and functional. As well as a structural analysis and dimensioning of the elements of the set with their respective planes.

2.1 Concept A

Starting from the premise "less is more" wanted to design a bench with clean and pure lines, with industrial and resistant materials.

Aluminum has been the chosen material, due to its characteristics (light and resistant).

The first approach was the use of curved sheets of aluminum to which would be added a seat based on wood or polypropylene.

As you can see in the images is a bench with a very refined aesthetic and a very aseptic line.



Image 1. Concept A

2.2 Concept B

Following the prerequisites for the development of the outside bench, this second option keeps the aluminum sheet curved but this time it is used longitudinally, making a set of very interesting lines and giving it the necessary stiffness and stability.

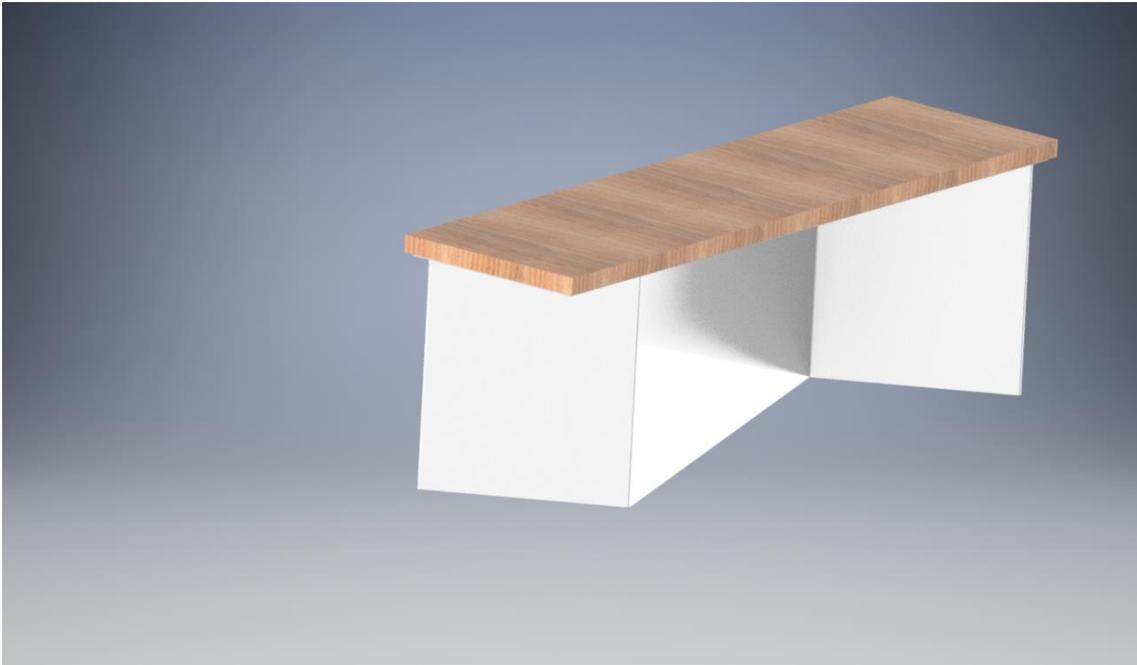


Image 2 Concept B

2.3 Specification of the Project

In this step, the best suitable concept will be selected as the project. There must be criterion table, to make this selection. All concepts in the table will be considered with respect to their specifications. Considering this, the best solution will be selected.

CRITERION TABLE

Properties	Weight	Concept A	Concept B
Reliability	%10	7	9
Costly	%5	9	8
Maintenance	%10	8	7
Energy Requirement	%10	8	7
Easy of Assembly	%10	9	8
Volume	%10	8	8
Safety	%15	7	10
Number of parts	%5	9	8
Durability	%15	7	9
Functionality	%10	9	9
Total Weight Point	%100	7.9	7.93

Although the difference is very small, it must be taken into account that when producing long series gives a greater profitability.

3. OVERALL DESIGN OF SELECTED CONCEPT

Once it have selected the best solution based on the criteria table, try to define the product completely to be able to produce it. It is necessary to know that the preparation of the documentation is inverse to its formal placement, these means that the first thing done is the plans for develop the technical sheets of each element of the set.

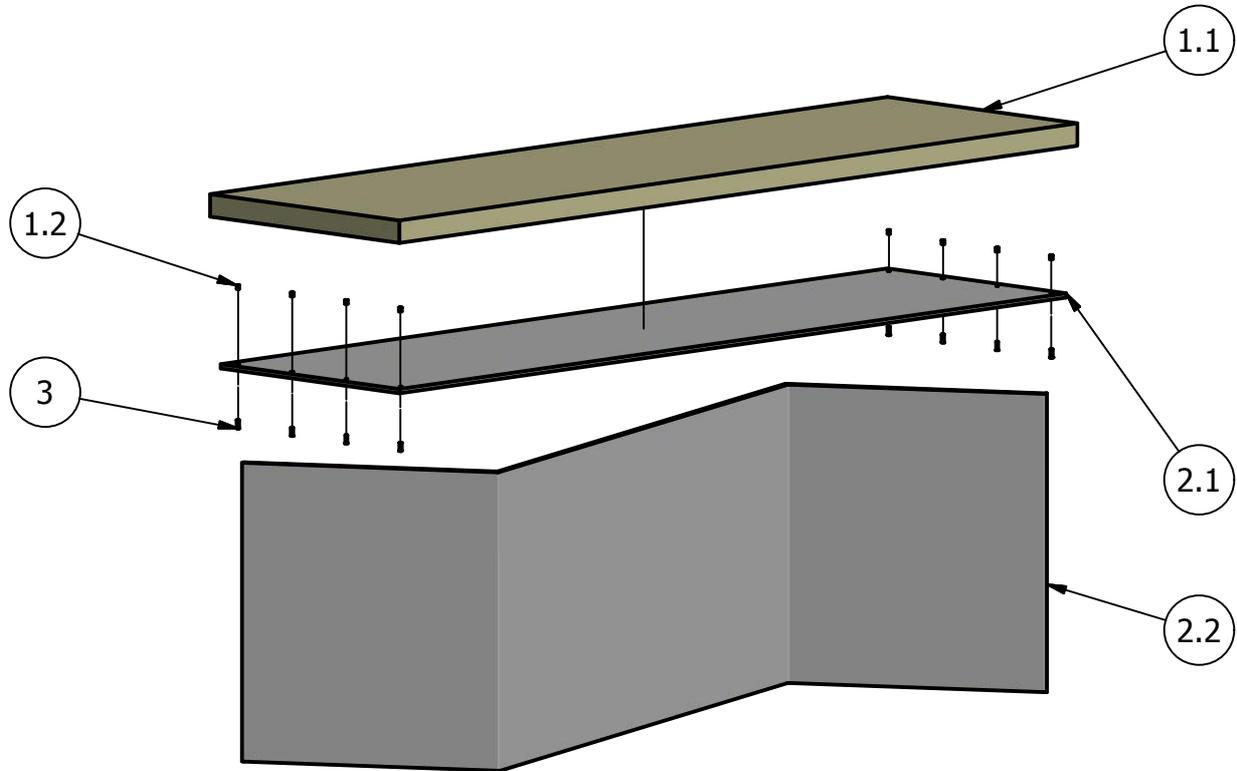
To define the product, first is the exploded view of the set, with marks and definition of each element, followed by a systematic diagram, where it is possible to see how the elements relates to each other. Planning of the activities for production with the respective table and diagram. These informs us of the necessary steps for the correct production of each piece. The PERT (Program Evaluation Review Table) is a project management tool used to schedule, organize, and coordinate tasks within a project.

Later on, it continues with the technical sheets that indicate the production process, the material, the machinery, the operators, the way of realization ...

It can also find the specific functions of use. To continue, anthropometric and structural studies to verify the minimum size and viability.

Finally, there are technical drawings: assembly, subset and element plans with their respective dimensions: general, functional and for production.

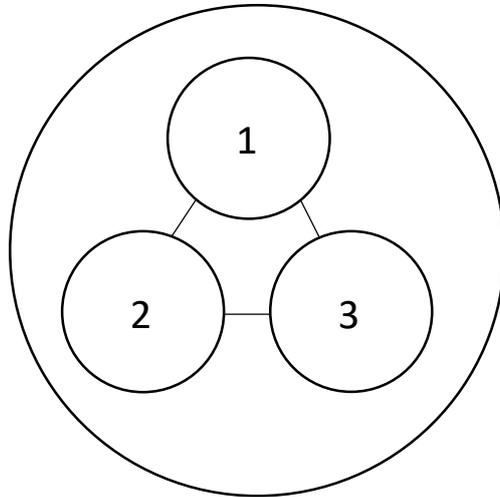
EXPLODED VIEW OF THE ASSEMBLY
WITH BRANDS AND LISTING OF ELEMENTS
Bench



PARTS LIST				
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
2.1	1	welded seat		Aluminum
2.2	1	support		aluminum
1.1	1	PP seat		Polypropylene
1.2	8	threaded insert		steel
3	8	screw		steel

SYSTEMIC DIAGRAM

PHASE I



PHASE II

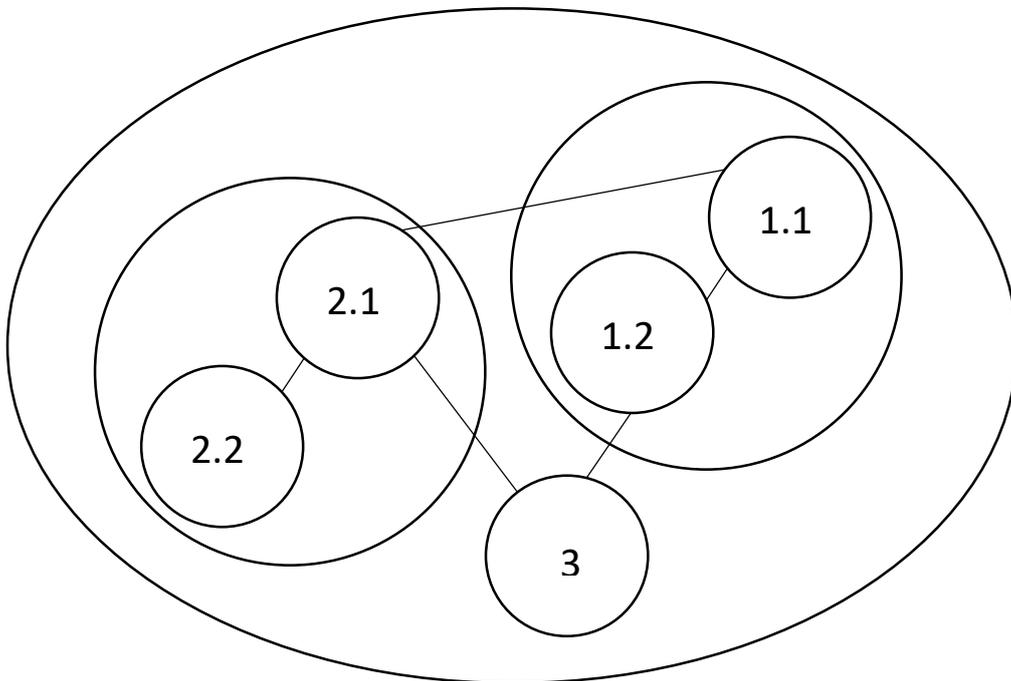
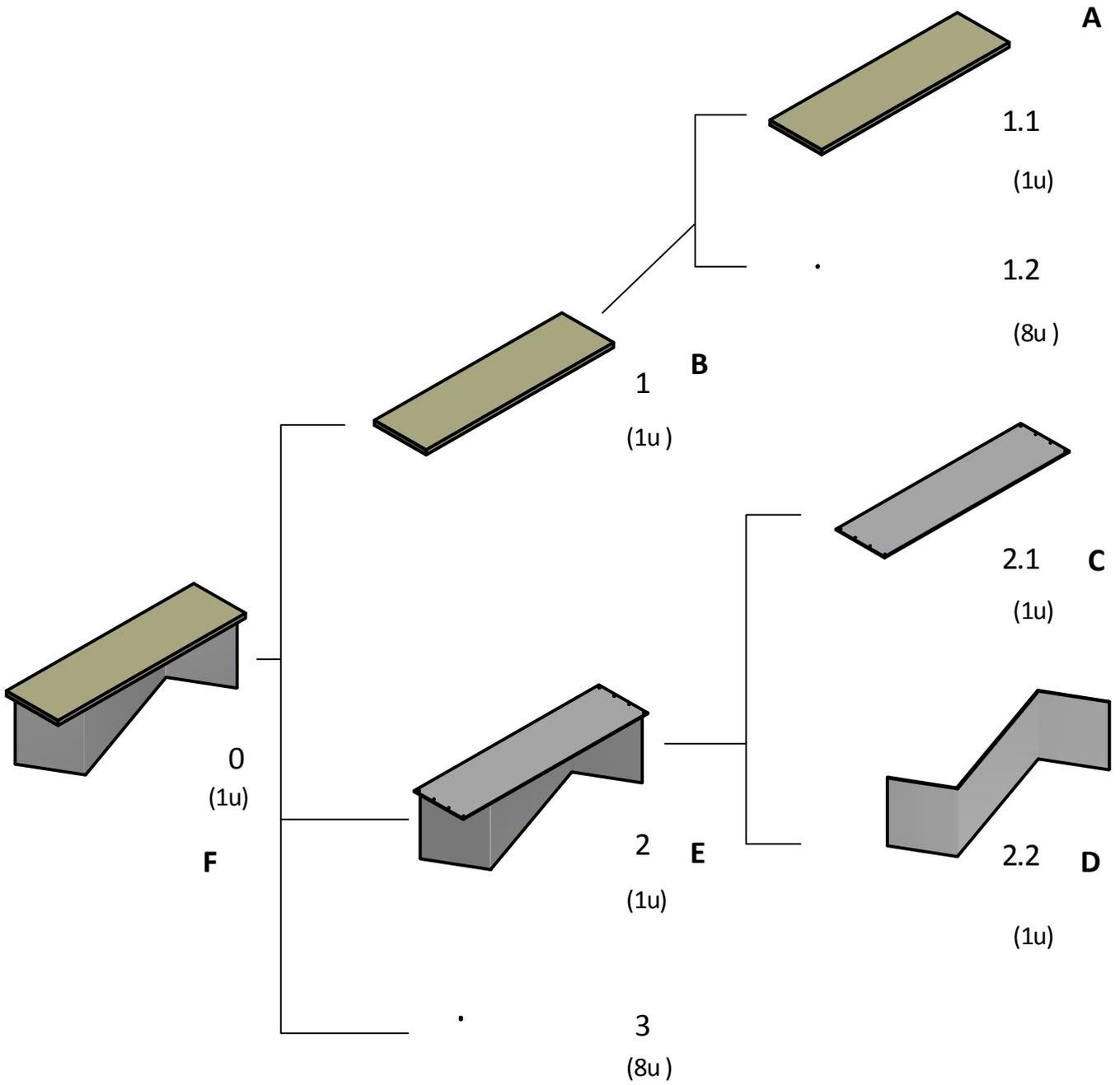


Image 4. Systemic Diagram

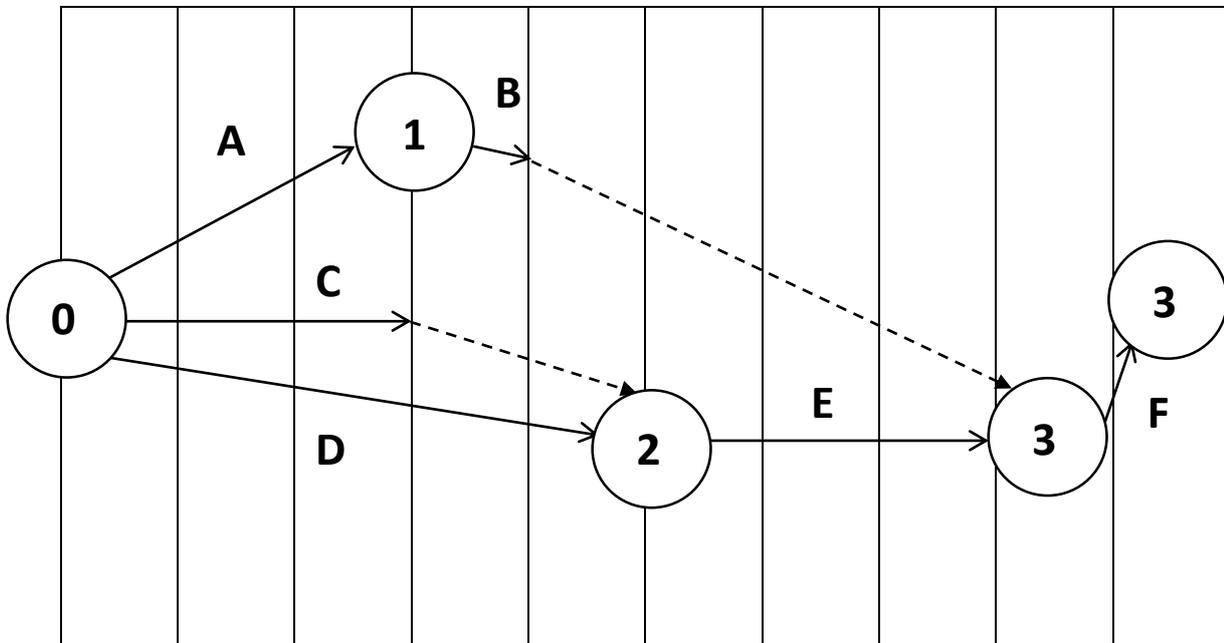
PLANNING OF ACTIVITIES
Assignment of activities PERT



PLANNING OF ACTIVITIES						
ELEMENT OR SUBSET	ACTIVITY	MARK	TIME* (t)	PREVIOUS ACTIVITIES	INMEDIATELY PREVIOUS ACTIVITIES	PARTIAL GRAPH
1.1	CUT MECHANIZE HOLE END	A	0,45			
SUBSET 1	INSERT	B	0,15	A	A	
2.1	CUT MECHANIZE HOLE	C	0,45			
2.2	CUT BEND MECHANIZE	D	0,75			
SUBSET 2	WELD	E	0,5	C, D	C, D	
SET	SCREW	F	0,15	A, B, C, D, E	B, E	

*Duration (t) is measured in hours

DIAGRAMA PERT



3.1 MATERIAL

This section specifies the materials needed to produce the product.

The material to be used of the components of the assembly and the reason for its use will be designated by means of a general explanation of its properties.

It will also mention the commercial elements used

3.2 TECHNICAL SPECIFICATIONS

Element number: 2.2 support

Material: Aluminum sheet [6mm]

1st Operation: Cut

Machinery: Milling machine [Morbidegli U-550 CNC 5 axis]

Labour: The cut can be carried out by an operator category "3th Officer"

Auxiliary means: Alloy steel cutter for aluminum cutting

Method:

1. Enter data in the miller software
2. Place the aluminum sheet inside the milling machine
3. Make the necessary cuts
4. Check that the dimensions are those indicated on the construction drawings

Security: Gloves, glasses, suitable clothing and safety boots, safety router of the milling machine

Controls:

1. Check the condition of the machines, tools and tools to be used, always at the beginning of operation.
2. Check how the operation was performed.
3. Check that the dimensions of the part coincide with those indicated on the drawings.

Tests: no need

2nd Opeation: Mechanize

Machinery: Milling machine

Labour: The operation can be carried out by an operator category "3th Officer"

Auxiliary means: Alloy steel roughing cutter for aluminum

Method:

1. Enter data in the miller software
2. Place the aluminum sheet inside the milling machine
3. The milling machine carries out the machining of the sheet
4. Check that the final result is correct and the necessary form has been obtained

Security: gloves, glasses, suitable clothing and safety boots, safety cabinet of the milling machine

Controls:

1. Check the condition of the machines, tools and tools to be used, always at the beginning of the operation
2. Check how the operation was performed.
3. Check that the dimensions of the part coincide with the indications in the drawings.

Tests: no need

3th Opeation: Round corners

Machinery: Angle grinder

Labour: The perforations may be carried out by an operator with the category of "3th Officer"

Auxiliary means: Aluminum roughing discs for aluminum

Method:

1. Connect the machine
2. Polish edges and corners
3. Perform a review
4. Check that rounding is correct

Security: gloves, glasses, suitable clothing and safety boots

Controls:

1. Check the status of the machines, tools and tools to be used, provided operating principle.
2. Check how the operation was performed.
3. Check that the radii of curvature are optimal.

Tests: no need

4th Opeation: Bend

Machinery: Hydraulic Press Mach One 175t

Labour: Aluminum blending canb be carried out by an operator with the category of “3th Officer”

Auxiliary means: Preform

Method:

1. Place the aluminum part on the press
2. Enter dubbing data
3. Carry out folding
4. Check that the curvature is correct

Security: gloves, glasses, suitable clothing and safety boots

Controls:

1. Check the condition of the machines, tools and tools to be used.
2. Check how the operation was performed.
3. Check that the folding is correct as stipulated in the construction drawings

Tests: no need

Element number: 2.1 welded seat

Material: Aluminum sheet [6mm]

1st Opeation: Cut

Machinery: Milling machine [Morbidelli U-550 CNC 5 axis]

Labour: The cut realization can be carried out by an operator category “3th Officer”

Auxiliary means: Alloy steel cutter for aluminum cutting

Method:

1. Enter data in the miller software
2. Place the aluminum sheet inside the milling machine
3. Make the necessary cuts
4. Check that the dimensions are those indicated on the construction drawings

Security: Gloves, glasses, suitable clothing and safety boots, safety router of the milling machine

Controls:

1. Check the condition of the machines, tools and tools to be used, always at the beginnign of operation.
2. Check how the operation was performed.
3. Check that the dimensions of the part coincide with those indicated on the drawings.

Tests: no need

2nd Opeation: Mechanize

Machinery: Milling machine

Labour: The operation can be carried out by an operator category “3th Officer”

Auxiliary means: Alloy steel roughing cutter for aluminum

Method:

1. Enter data in the miller software
2. Place the aluminum sheet inside the milling machine
3. The milling machine carries out the machining of the sheet
4. Check that the final result is correct and the necessary form has been obtained

Security: gloves, glasses, suitable clothing and safety boots, safety cabinet of the milling machine

Controls:

1. Check the condition of the machines, tools and tools to be used, always at the beginning of the operation
2. Check how the operation was performed.
3. Check that the dimensions of the part coincide with the indications in the drawings.

Tests: no need

3th Opeation: Die cut

Machinery: Milling machine Morbidelli U-550 CNC 5 axes

Labour: Punching of the holes can be performed by an operator with category “3th Officer”

Auxiliary means: Alloy steel roughing cutter for aluminum

Method:

1. Enter the data in the milling machine software
2. Carry out the hole
3. Check that the result is correct

Security: gloves, glasses, suitable clothing and safety boots, safety cabinet of the milling machine

Controls:

1. Check the condition of the machines, tools and tools to be used
2. Check how the operation was performed.
3. Check that the dimensions of the die are adequate and according

Tests: no need

Subset number: 2 Support and base seat

Material: Aluminum sheet [6mm]

1st Operation: Welding

Machinery: Welder

Auxiliary means: Gas, work table

Labour: The welding can be carried out by an operator category "2nd Officer"

Method:

1. Put the sheet to be welded over the working surface
2. Position the support correctly on the base
3. Turn on machinery
4. Proceed to weld
5. Check the result

Security: gloves, mask, suitable clothing and safety boots.

Controls:

1. Check the condition of the machines, tools and tools to be used
2. Check how the operation was performed
3. Check that the joint is adequate

Tests: no need

3.3 FUNCTIONAL SPECIFICATION OF USE

From the initial conditions and a market study, it was considered that the product should have the following relation of functions of use:

MAIN USAGE FUNCTIONS:

Firstly, the main functions required by the proposed design are based on the possibility exposed and the needs analyzed. The main practical function is seat.

COMPLEMENTARY FUNCTIONS OF USE:

The following is a list of functions derived from the bench's own use, its manipulation and usage environment, and the functions analyzed in the Market Study of analogous products and their functions.

FUNCTIONS DERIVED FROM USE:

easy to carry and handle, easy to store, easy to clean

FUNCTIONS OF ANALOGOUS PRODUCTS:

to have aesthetics different from similar products.

RESTRICTIVE FUNCTIONS:

Safety functions, sporadic, non-fault and temporary functions, functions derived from negative impacts and their own functions derived from their manufacture, trade, use, maintenance, repair and withdrawal are set out below.

SAFETY FUNCTIONS IN USE:

The use of curved shapes with wide radius as well as the use of rounded corners.

AESTHETIC FUNCTIONS:

As for the aesthetic function of the product developed, it can be said that it has a high decorative value given by the set of curves and plans together with materials and surface finishes.

4. DETERMINATION AND SELECTION OF PARTS

For the realization of the bench we are subject to the anthropometry, for a viable and comfortable use. The structural specifications that guarantee the use. The following are the minimum dimensions and the structural studies performed with the software.

Anthropometric analysis

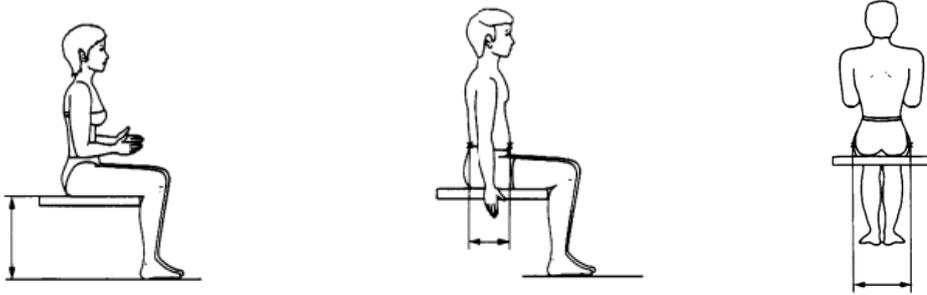


Image 6. Anthropometric measures

Structural analysis

A structural analysis is performed with the software Autocad Inventor. It is a simulation of the efforts which the bench will have.

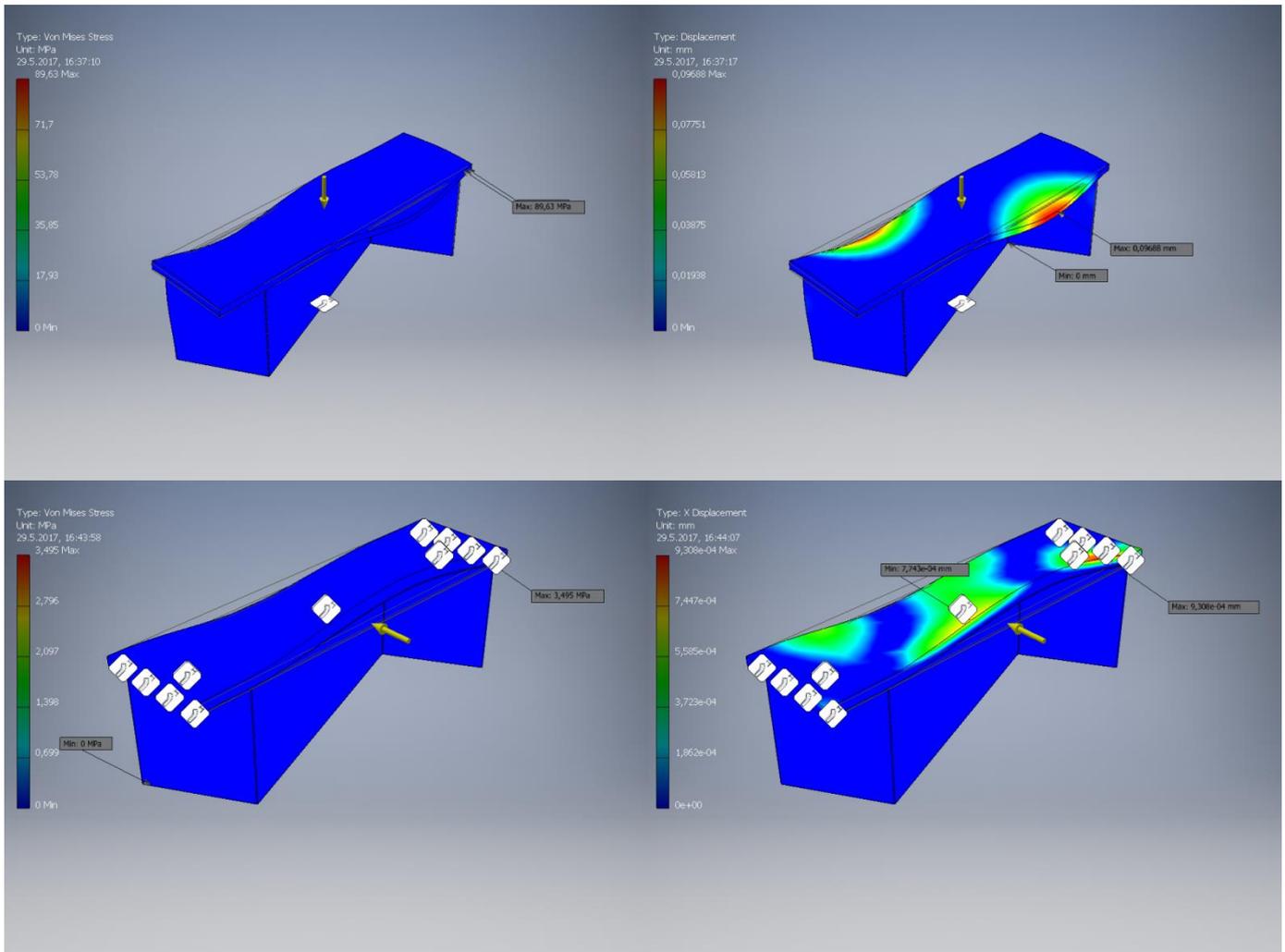


Image 7. Structural analysis simulation

An aluminum alloy 6061 is chosen

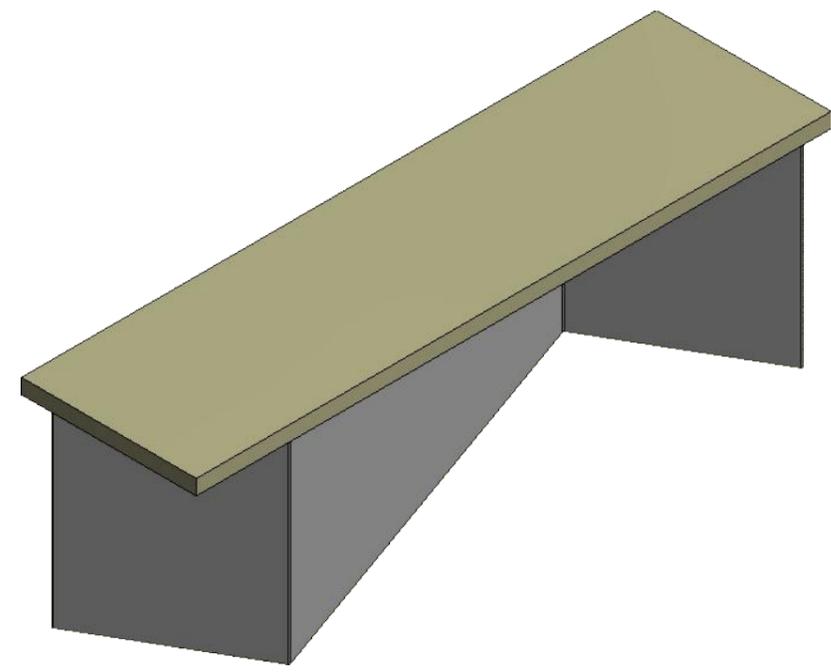
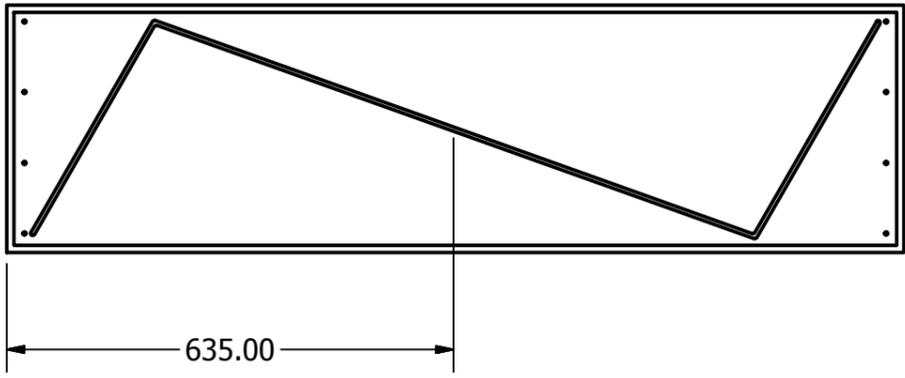
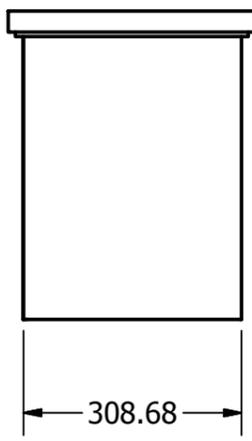
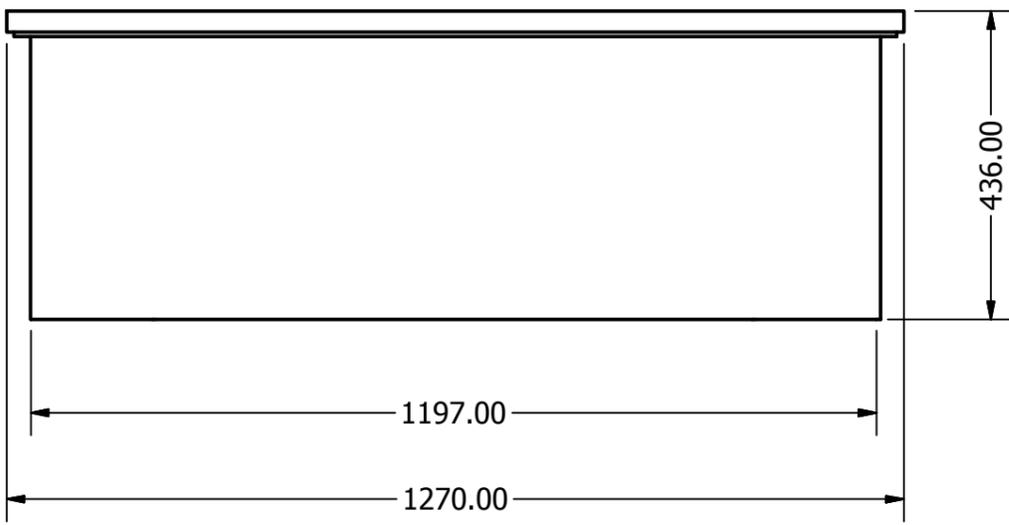
An assumption of a Force of 2000N is presented. It limits the area of surface which is going to work as well as the points of support that unite to the structure of the bench.

In the simulation the deformation when applying the pressures is observed.

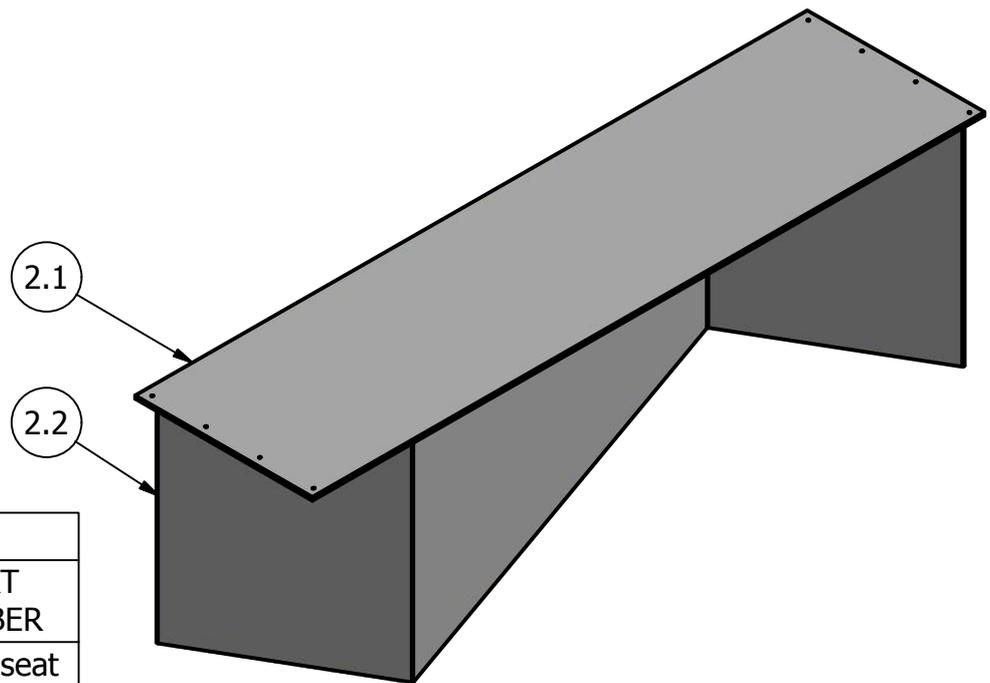
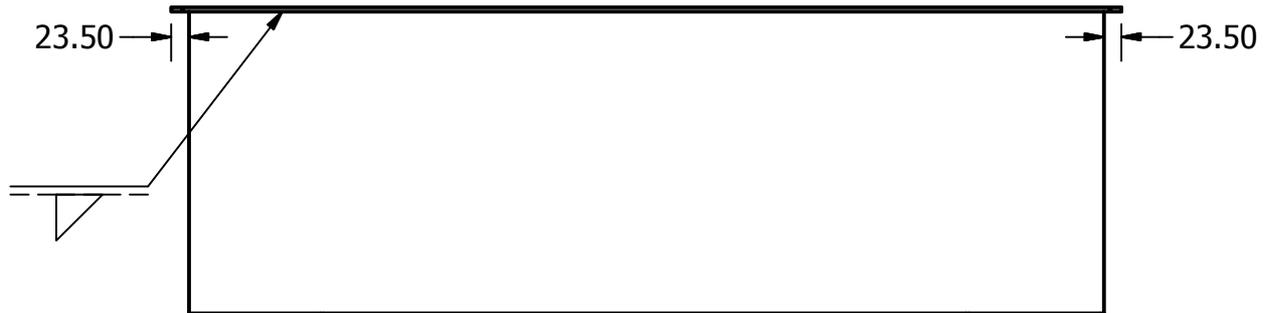
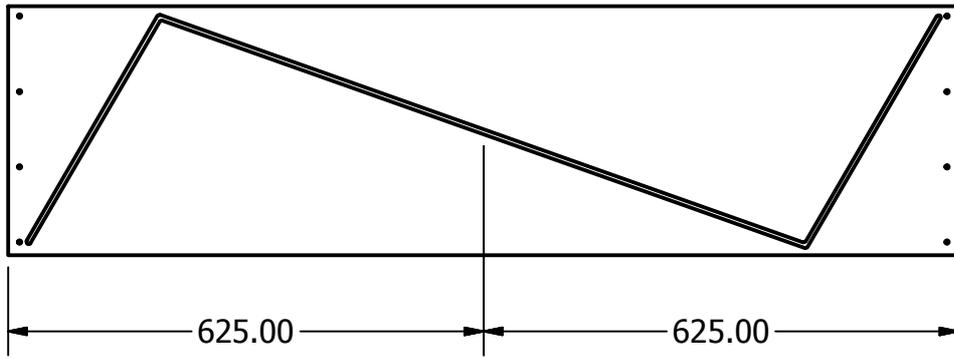
It can also check how the forces of Von Mises for ductile materials such as aluminum.

It can be seen that the simulations are far from the elastic limit and that the deviations that are projected are minimal, both for resistance and stability calculations. Therefore, the structural viability of the product can be affirmed.

5. TECHNICAL DRAWINGS



DRAWN xavier_roman	25.5.2017	TITLE ASSEMBLY DRAWING		
CHECKED				
QA				
MFG				
APPROVED		SIZE A3	DWG NO	REV
		SCALE 1 : 10	SHEET 1 OF 1	

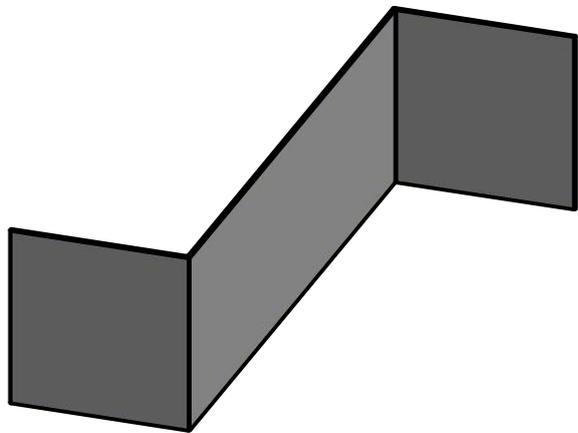
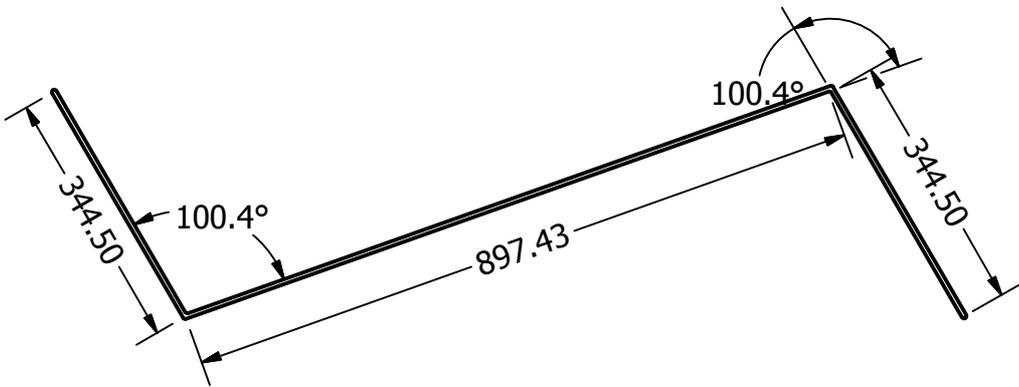
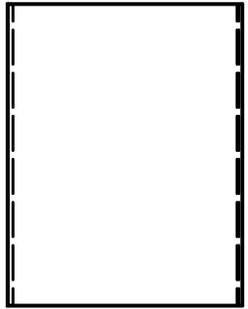


PARTS LIST		
ITEM	QTY	PART NUMBER
2.1	1	welded seat
2.2	1	support

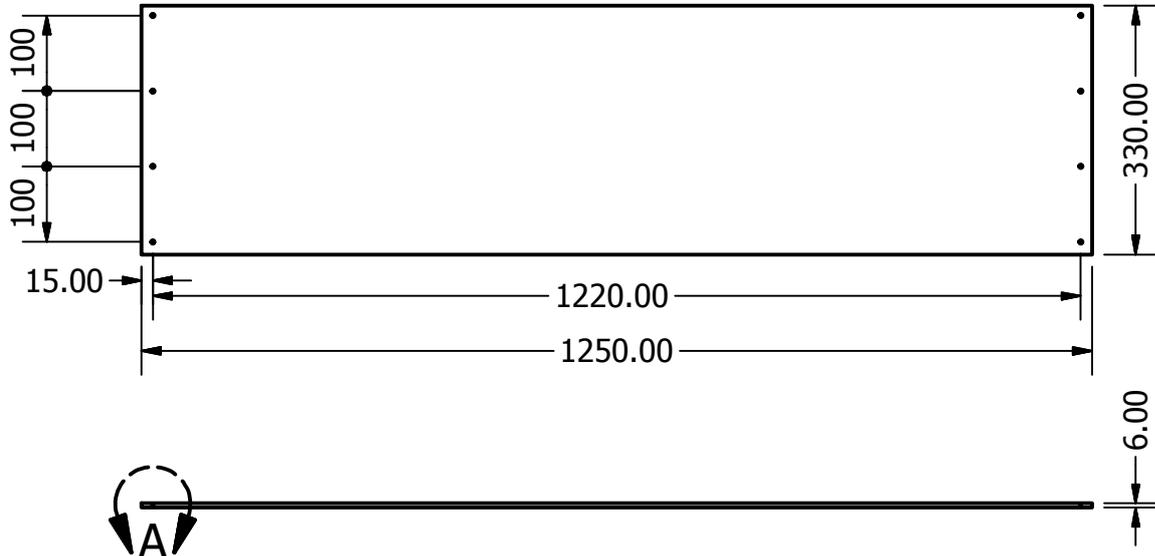
DRAWN xavier_roman	29.5.2017			
CHECKED		TITLE		
QA		PLANE SET 2		
MFG				
APPROVED		SIZE A4	DWG NO	REV
		SCALE 1:10	SHEET 1 OF 1	



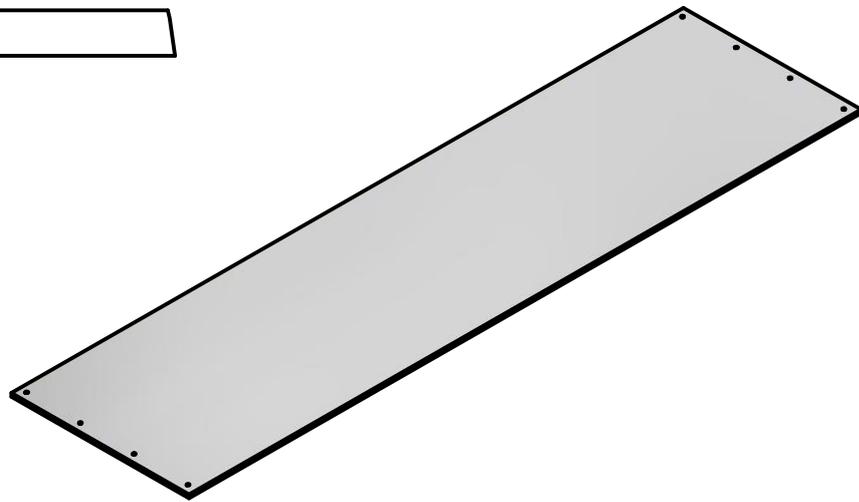
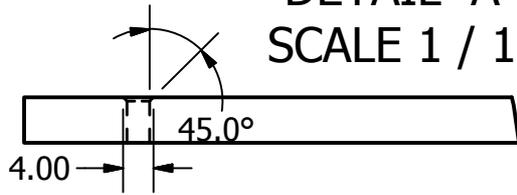
400.00



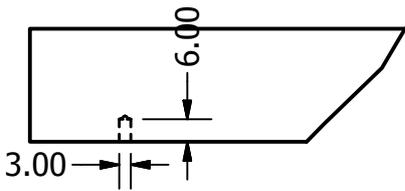
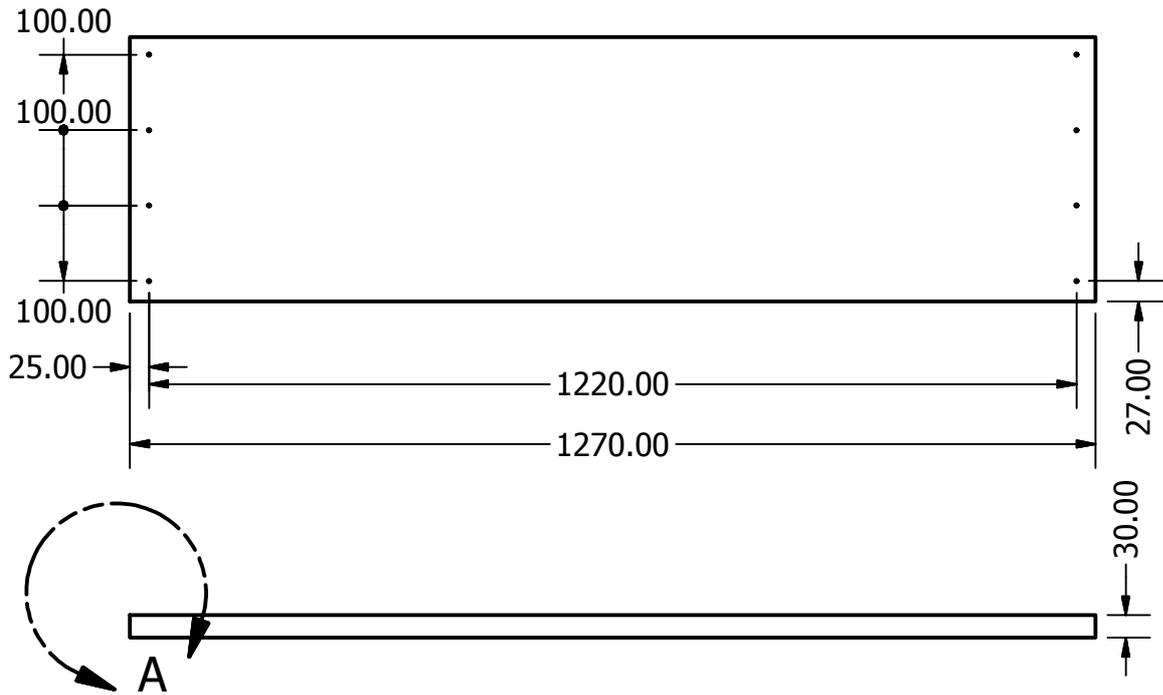
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CHECKED		TITLE		
QA		PLANE ELEMENT 2.2		
MFG				
APPROVED				
		SIZE A4	DWG NO	REV
		SCALE 1:10	SHEET 1 OF 1	



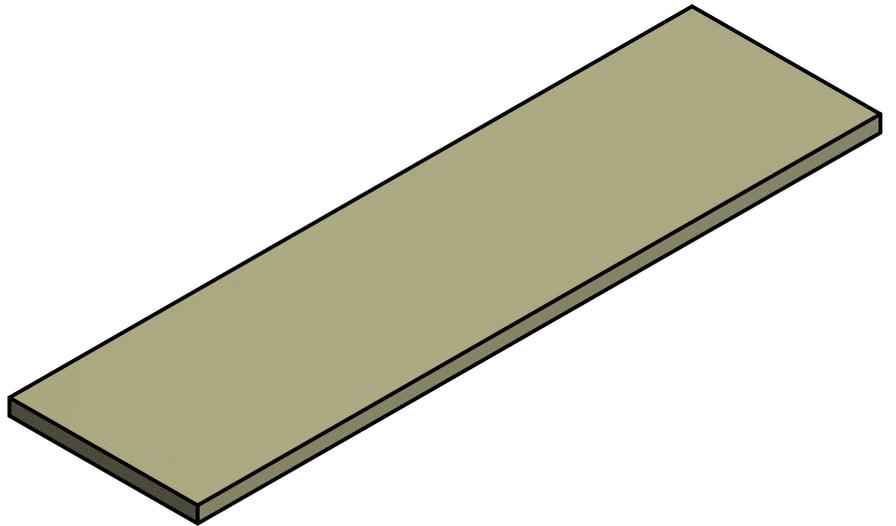
DETAIL A
SCALE 1 / 1



DRAWN xavier_roman	29.5.2017			
CHECKED		TITLE		
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MFG				
APPROVED				
		SIZE A4	DWG NO	REV
		SCALE 1:10	SHEET 1 OF 1	



DETAIL A
SCALE 1 / 2



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QA		PLANE ELEMENT 1.1		
MFG				
APPROVED		SIZE A4	DWG NO PLANO ELEMENTO 1	REV
		SCALE 1:10	SHEET 1 OF 1	

6. CONCLUSIONS

Always following the purity and cleanliness of the curved aluminum, it is played to arrive at the optimal solution.

Finally it can be concluded that the objectives to design the products have fulfilled satisfactorily and the final design meets all the requirements that were exposed.

A very different aesthetic has been achieved with similar products, with greater attractiveness, using linear forms and materials uncommon in the field.

Always following the purity and cleanliness of the curved aluminum, it is played to arrive at the optimal solution.

7. REFERENCES

Materials

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Regulations

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Products

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<http://www.frontgate.com/outdoor-furniture>