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ESCUELA POLITÉCNICA DE INGENIERÍA DE GIJÓN.

GRADO EN INGENIERÍA MECÁNICA

ÁREA DE MECÁNICA DE MEDIOS CONTINUOS Y TEORÍA DE ESTRUCUTURAS

PULL-OUT EXTENSION SYSTEM OF LIVING SPACE IN VAN: SLIDING/ROLLING SYSTEM, ITS DRIVE AND OTHER RELATED COMPONENTS DESIGN

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OBJETIVOS DEL PROYECTO

El objetivo del proyecto es el diseño de una caja móvil que puede ser montada dentro de la sección de carga de los vehículos tipo furgoneta. Después de expulsarla durante el aparcamiento, la caja debe permitir que el vehículo pueda obtener un significativo espacio útil adicional.

Con el fin de maximizar el espacio útil, se considerará el uso de una caja móvil expandible. Una vez que esté fuera de la furgoneta, se desdoblaran las paredes de la caja para dar más espacio al usuario.

Hay dos componentes principales del sistema: la caja expandible y el sistema de deslizamiento.

La caja también está equipada con algunos muebles. Una parte de los muebles se oculta en el interior de la caja y no se utiliza durante el viaje.

Fig. 1. presenta una sencilla explicación gráfica del concepto donde:

- Etapa I es el proceso de extraer (sacar) la caja.

- Etapa II es el proceso de expansión de la caja.

- Etapa I.a es la acción contraria de la Etapa I, introduciendo la caja en la furgoneta.

- Etapa II.a, es la acción opuesta de la Etapa II, en la cual se doblan las paredes de la caja.

Las partes principales del proyecto son:

- Análisis de soluciones y supuestos para el proyecto.

- Descripción y análisis de las posibles soluciones.

- Desarrollo del concepto elegido mediante la aplicación de SolidWorks.

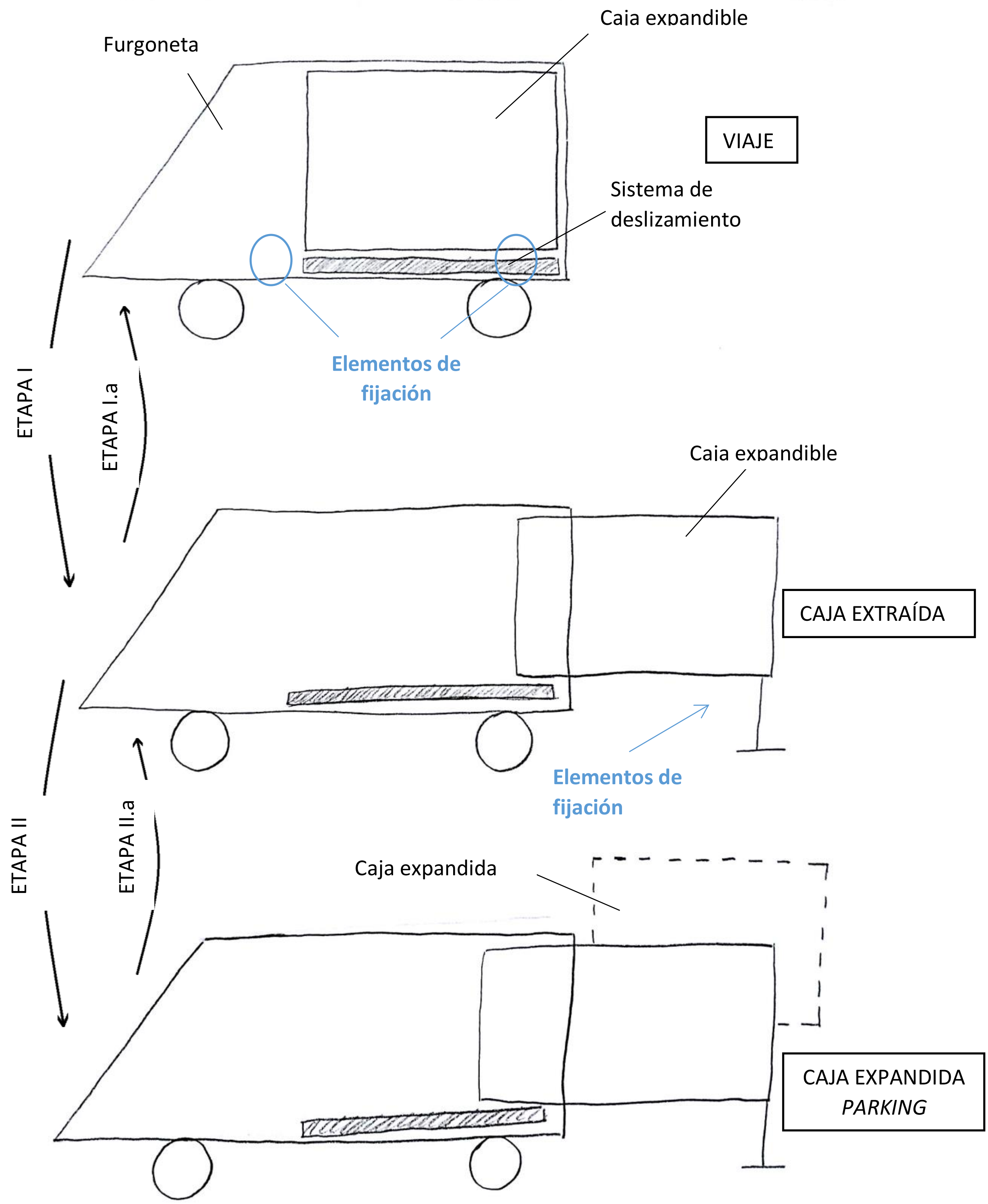


Fig. 1. Representación gráfica simplificada del sistema a diseñar

DISEÑO DEL SISTEMA

El diseño final del sistema se presenta en este capítulo.

Está compuesto por la caja principal a la que el sistema expandible y el de deslizamiento están unidos. El sistema de deslizamiento también está conectado a la furgoneta, permitiendo que la caja se mueva fuera de ella.

Las dimensiones de los componentes que forman la parte expansible de la caja móvil están limitadas por las dimensiones externas de la caja principal (Fig. 10.).

La solución aplicada se presenta en la Fig. 38., la cual permite obtener un espacio adicional de, aproximadamente, 7 metros cúbicos, siendo la superficie extra de 6 metros cuadrados.

Fig. 38. muestra todo el conjunto del sistema con sus principales subconjuntos.

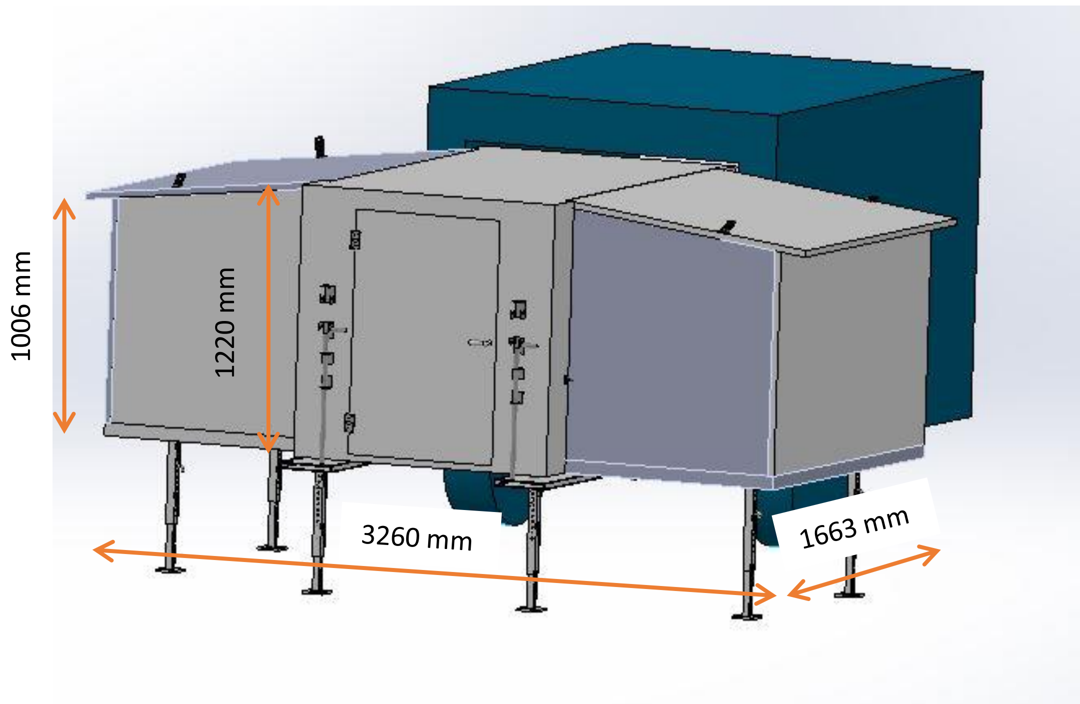


Fig. 38 a. Presentación general del sistema

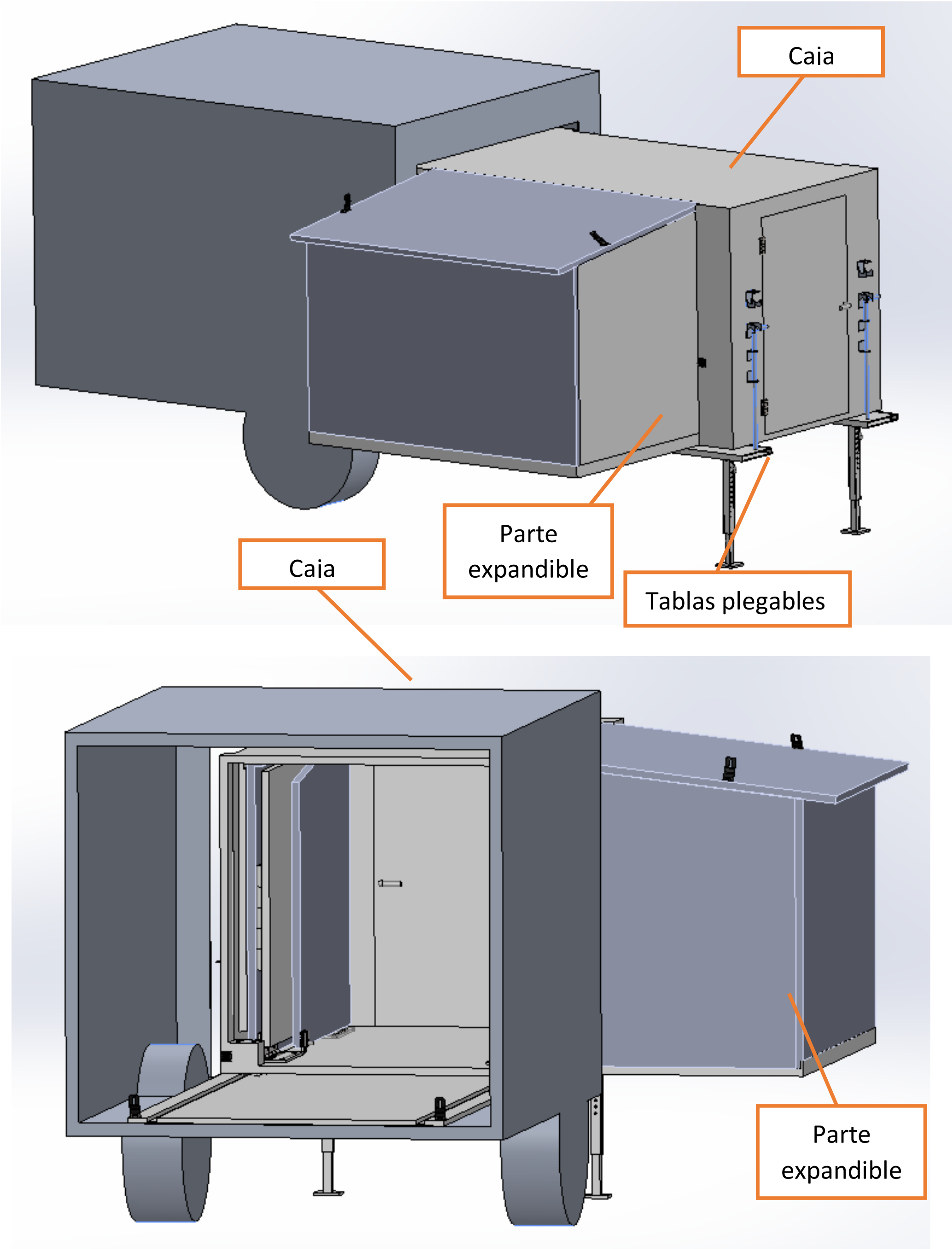


Fig. 38 b. General presentation of the system

La caja está fabricada por IPM-Mondia, es una empresa que fabrica paneles sandwich (ver Fig. 42) hecho a medida y también chasis. Resuelve el problema de la fabricación de la caja, un dibujo con las medidas es lo único necesario. También realizarían la puerta de la caja principal.

Esta compañía también tiene una buena solución para los paneles utilizados para las paredes, algunos de ellos tienen un reborde, tal como se muestra en la Fig. 43., que está hecho de madera.

La caja está compuesta por las siguientes partes:

- Chasis: es el componente principal.

- Puerta: también está hecha por paneles sándwich. Está fijada a la furgoneta con algunas bisagras.

- Las placas de aluminio: se usan para cubrir los agujeros para las ruedas y para fijarlos a la caja. Están soldadas al chasis.

SISTEMA DE DESLIZAMIENTO

Este sistema (Fig. 44) permite al usuario mover la caja de la furgoneta hacia el exterior y a la inversa.

Se compone de un suelo de madera unido a la camioneta con dos guías paralelas para facilitar el movimiento de las 4 ruedas (Fig. 25 a.) de la caja. Con el fin de extraer la caja de la furgoneta, cuatro tablas plegables (Fig. 28.) están unidas al suelo por medio de algunas bisagras y se fijan al terreno con dos soportes fijos. Debido a que las furgonetas tienen un saliente fuera de las puertas traseras, estas tablas plegables han de sufrir algunas modificaciones ya que, en caso contrario, las ruedas deberían superar una saliente de 30 mm que requeriría una gran fuerza.

Para introducir las tablas plegables en la furgoneta después de que la caja haya sido guardada, hay que quitar los soportes fijos, ya que éstos son independientes y se transportan sueltos en el interior de la furgoneta.

La rigidez del sistema en la división entre ambas tablas se incrementó por medio de una gran bisagra y dos piezas adicionales.

Otra forma de realización de este sistema sería con perfiles en U en lugar de tubos rectangulares para evitar el corte de la parte frontal de las tablas, pero, de ser así, la rigidez no se podría aumentar por medio de la parte usada y probablemente no soportaría la carga o tiene un gran desplazamiento.

SISTEMA EXPANDIBLE

Este sistema permite al usuario obtener más espacio cuando la caja está fuera de la furgoneta. Se une a la caja principal por medio de algunas bisagras y a la tierra por algún soporte fijo unido al terreno.

El mecanismo es sencillo; las paredes se unen a la caja y, desplegandolas en cada una de las partes laterales de la caja, se obtiene dos "habitaciones" más.

Antes de la introducción de la caja dentro de la furgoneta, este sistema debe ser desplegado y fijado a la caja con algunos cierres unidos en el interior y el exterior de la misma (ver Fig. 47).

Las paredes también están hechas de material tipo sándwich. La primera idea era mecanizar las paredes, suelos y techos con el fin de fijar las bisagras para que no se obstaculizara el caminar dentro de la caja, pero, ya que están hechos de material compuesto, es más fácil y más seguro fijarlas a la cubierta de aluminio del material compuesto que a la parte interior.

CÁLCULOS

A continuación, se presentan algunos cálculos de resistencia relacionadas con los elementos del sistema seleccionado. Todos los cálculos se han realizado con SolidWorks con un factor de seguridad de 3.

CAJA

El piso de la caja está hecho de material compuesto, con 4 agujeros para las ruedas que están cerradas con algunas placas de aluminio soldadas a la caja. Los cálculos se realizaron con el fin de saber si soportaría 1 tonelada de masa. Los resultados se muestran a continuación.

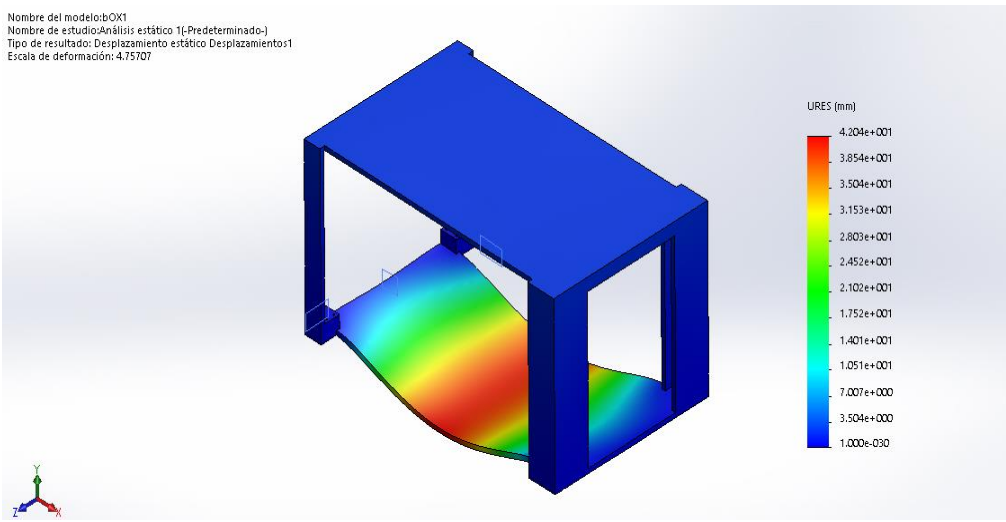


Fig. 48. Resultados de desplazamientos

En la Fig. 48. es posible ver que el desplazamiento en la parte central de la caja será de 4 cm con una masa de 1 tonelada; no es un mal resultado teniendo en cuenta el factor de seguridad empleado y que el peso es muy superior al que deberá soportar el suelo de la caja.

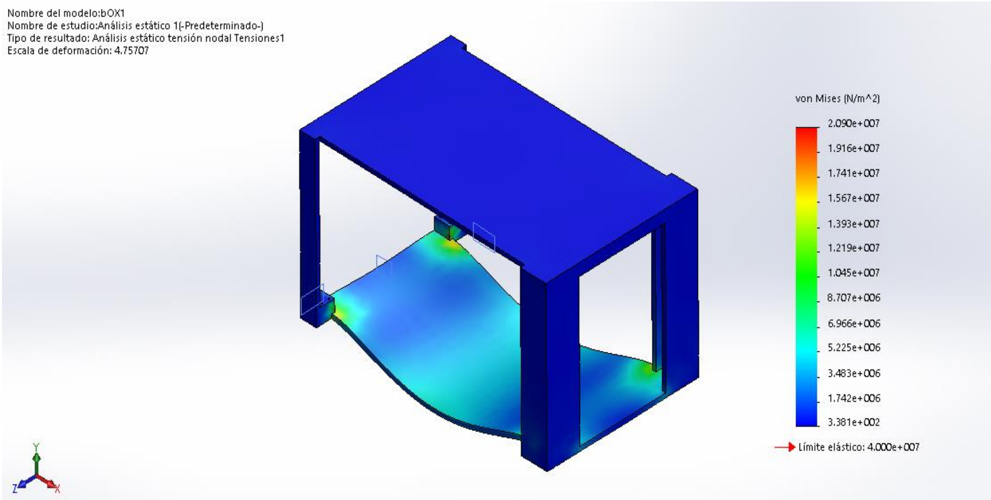


Fig. 49. Resultados de esfuerzos

Por otro lado, en la Fig. 49., por medio de una escala gráfica, se muestra los esfuerzos soportados por la caja. Se puede deducir que las partes que sufren más estrés son las cajas de rueda (21 MPa). El límite de elasticidad para el aluminio es 435 MPa y para los paneles compuestos es de alrededor de 40 MPa, por tanto, la caja soportará la masa sin romperse.

SISTEMA DE DESLIZAMIENTO

En este sistema, los dos cálculos se han realizado con el fin de saber si las tablas plegables soportarán 1 tonelada de masa, mientras que la caja es extraída. En la Fig. 50. es posible ver que la malla está más refinada cerca de los puntos críticos.

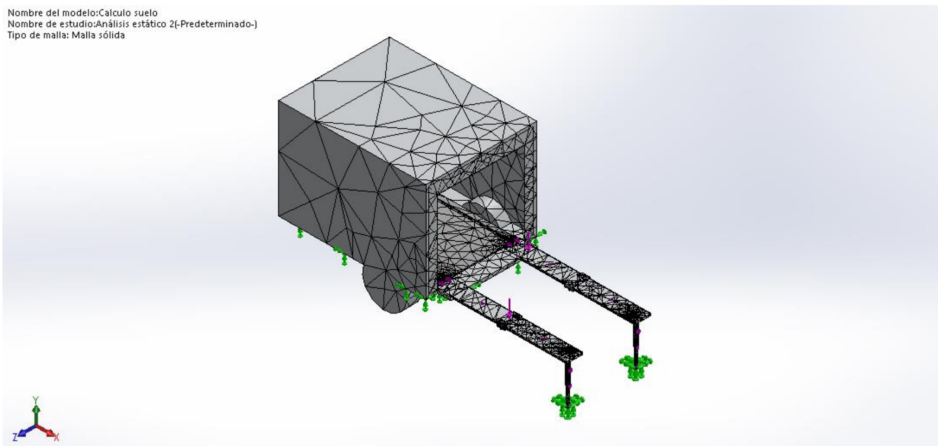


Fig. 50. Malla

Las dos posiciones críticas (Fig. 51.) se valoran a continuación.

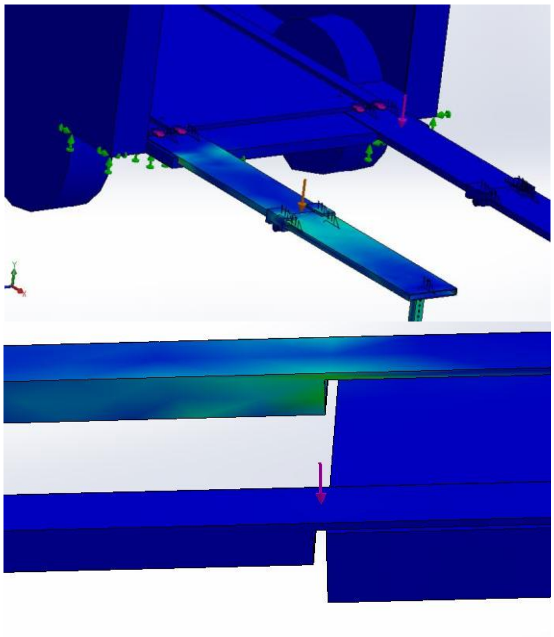


Fig. 51. Puntos críticos

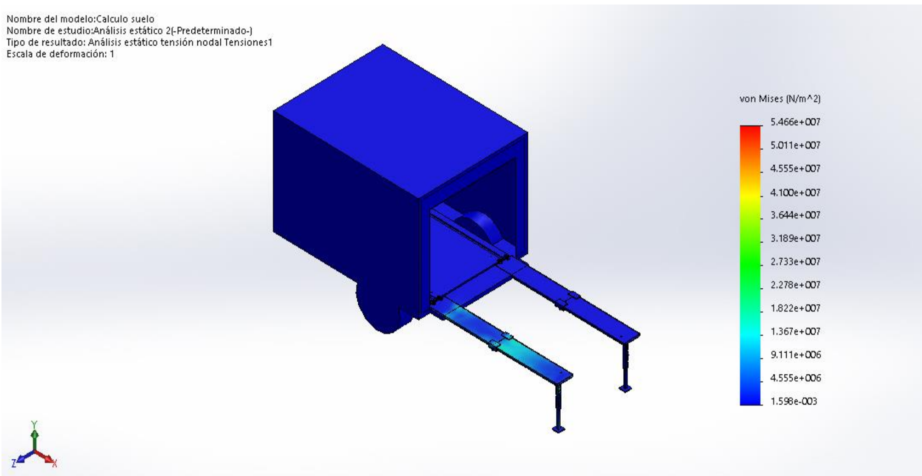


Fig. 52. Resultados de esfuerzos

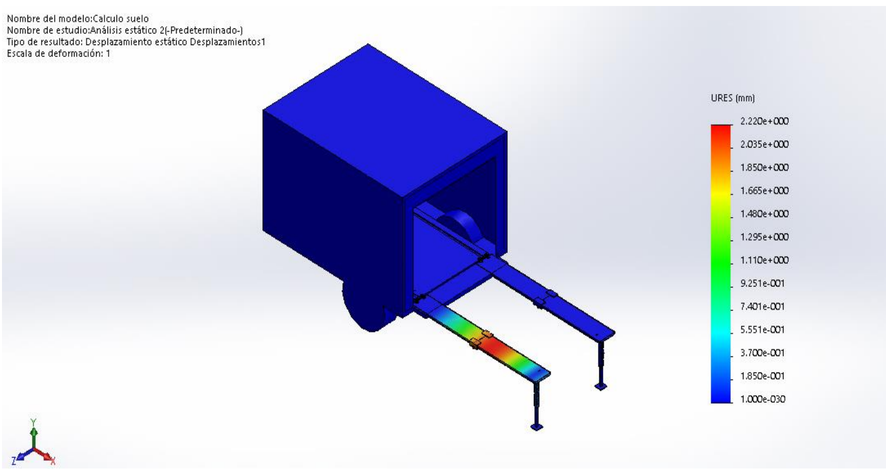


Fig. 53. Resultados de desplazamientos

En el primer caso, la rueda está en el primer punto que sale de la sujeción de la furgoneta.

En el otro caso, las ruedas están entre ambas tablas.

En ambos casos las mesas plegables soportan el peso debido a que la tensión máxima es 54 MPa (Fig. 52.) y el límite elástico del aluminio es 435 MPa. El desplazamiento máximo es de aproximadamente 2 mm (Fig. 53.).

MONTAJE EN LA FURGONETA

La única parte fijada a la furgoneta es el suelo por medio de unos tornillos en las esquinas y el centro de la tabla de madera. No hay necesidad de agujeros o marcas preliminares, el usuario sólo tiene que atornillar directamente en algún lugar cerca de las posiciones especificadas.

MOBILIARIO Y COMPONENTES ADICIONALES

Para mejorar la comodidad en el interior de la furgoneta y la caja, algunas ideas de muebles plegables se han desarrollado.

CAMA

Mientras que la caja está dentro de la furgoneta, a ambos lados de ella hay un espacio vacío (encima de las ruedas), de manera que, con el fin de aprovechar todo ese espacio, dos camas (una en cada lado de la furgoneta) se colocan como se muestra en Fig. 54.

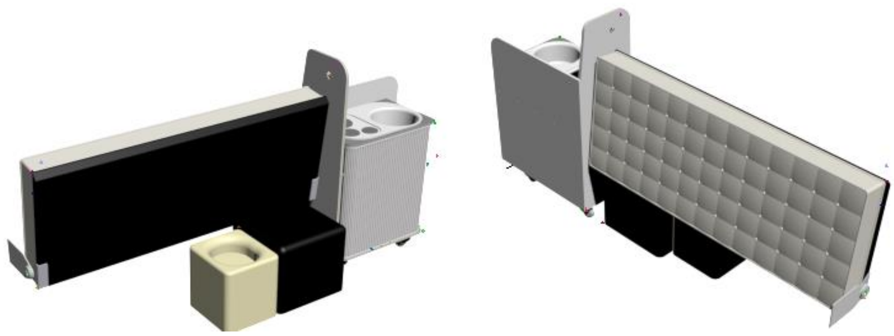


Fig. 54. Cama

Es posible añadir un soporte cuadrado adicional (como los de la Fig. 54.) para dar más estabilidad a las camas mientras estén abiertas. Este apoyo podría ser transportado dentro de la caja.

MESA

Hay dos diseños para las mesas, en función de si se requiere una grande o una pequeña. Se muestran en la Fig. 55. y la Fig. 56.

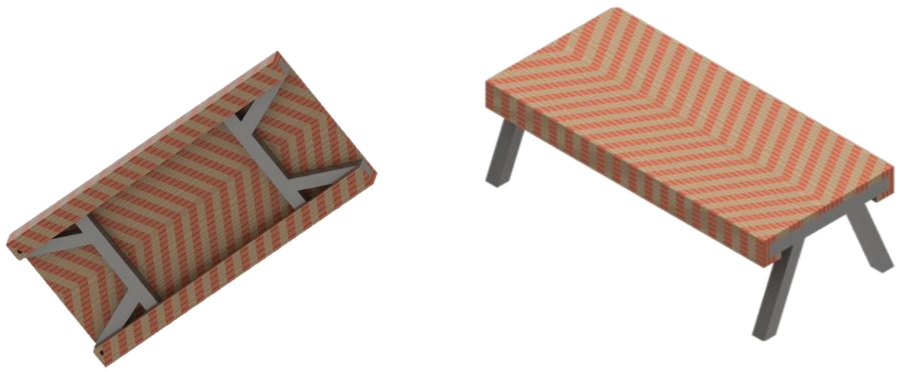


Fig. 55. Diseño de mesa 1

Fig. 56. Diseño de mesa 2

ASIENTOS

Algunas ideas para los asientos plegables se muestran en Fig. 57. y Fig. 58.

Fig. 57. Diseño de asientos 1

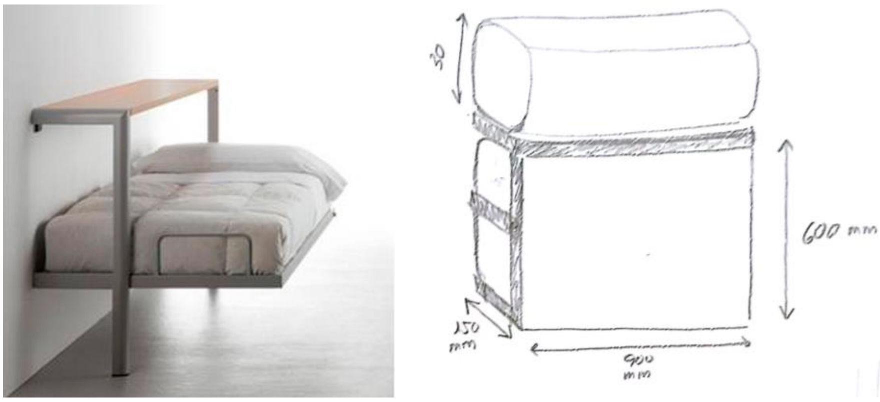


Fig. 58. Diseño de asientos 2

En la Fig. 58., a partir de una idea de una cama plegable, se desarrolla un asiento. La conversión de la estructura externa en una especie de caja que se sujetaría sin elementos de fijación. Se añadiría un respaldo mediante la introducción de una forma rectangular a través de los orificios superiores mientras que el asiento está desplegado.

LAVABO

Para un uso más cómodo del agua para cocinar, lavar u otras actividades, un fregadero con una bomba de agua se puede incluir a los muebles. Una idea general se muestra en la Fig. 59

Fig. 59. Lavabo

CONCLUSIÓN

El sistema de la caja móvil / expansible para vehículos tipo furgoneta ha sido diseñado en este proyecto. La caja se puede montar dentro de la sección de carga / pasajeros de la furgoneta y permite que el vehículo pueda obtener un significativo espacio útil adicional.

La solución propuesta y sus parámetros técnicos y económicos indican que los requisitos establecidos (tabla 1) y supuestos (capítulo 3) se han cumplido.

En primer lugar, el costo del sistema parece ser relativamente bajo (alrededor de 1.140€; véase el capítulo 5.8).

La caja móvil y expandible permite que el vehículo pueda conseguir un espacio de 7 metros cúbicos adicionales.

Es muy importante señalar que el sistema propuesto no está diseñado para sólo un modelo de coche. Puede ser instalado en un número de furgonetas fabricados actualmente (capítulo 4.1).

La fabricación del sistema propuesto es muy simple. El montaje en la furgoneta (después de realizar un premontaje de las piezas soldadas en la fábrica) no causaría ningún problema para el usuario.

Un fácil uso y mantenimiento del sistema es posible debido a su sencillez.

Algunos bocetos e ideas de muebles plegables que pueden ser añadidos al sistema se muestran en el capítulo 5.6.

Este sistema también ha cumplido con algunos deseos que se describen en el capítulo 3.2, que son la ligereza de los elementos (sistema completo 172kg) y el uso de materiales aislantes de las paredes de la caja, lo que proporciona un alto nivel de confort.

Sin embargo, esta solución ha de ser considerada como un prototipo. Se puede mejorar en muchos aspectos: la adición de algunas ventanas a las paredes, el desarrollo de las ideas del mobiliario plegable, mejorar el diseño y el acceso a la caja desde el exterior. También se podría mejorar la impermeabilidad de la caja. Por último, un sistema eléctrico podría ser instalado para mejorar la experiencia del usuario y un nivel circular para facilitar la colocación del sistema de deslizamiento exterior, así como la automatización del sistema de deslizamiento para facilitar su extracción.

CONTENTS

Distribution of work (if not specified, the chapter has been performed by both authors):

- L F R: number of chapters/subchapters 4.3, 5.3, 5.6, 5.8
- G M A: number of chapters/subchapters 4.2, 5.1, 5.2, 5.4, 5.5

1 OBJECTIVES OF THE PROJECT

The objective of the project is to design movable box that can be mounted inside the cargo section of van-type vehicles. After ejecting outside during parking, the box should allow the vehicle to obtain significant additional usable space.

In order to maximize the usable space, an expandable movable box will be considered. Once it is outside the van, the walls of the box will be unfolded giving more space to the user.

There are two main components of the system to be design: the expandable box and the sliding system, which is necessary to draw out (and back) the box.

Additional system elements are support/fixing elements, to fix the expandable box inside the van vehicle while travelling, and to support and fix the expanded box outside the van during parking.

The expandable box should be also equipped with some furniture. Some part of the furniture will be hidden inside the box and not used during travelling.

Fig. 1. presents a simple graphical explanation of the concept where:

- Step I is the process of extracting (pulling out) the box.
- Step II is the process of expanding the box.
- Step I.a is the opposite action of Step I, pushing the box into the van.
- Step II.a in the opposite action of Step II, folding the box.

Main parts of the Project are:

- Analysis of existing solutions and assumptions to project. (Chapters 2 and 3)
- Description and analysis of possible solutions. (Chapter 4)
- Detailed project related to the chosen concept by application of SolidWorks. (Chapter 5)

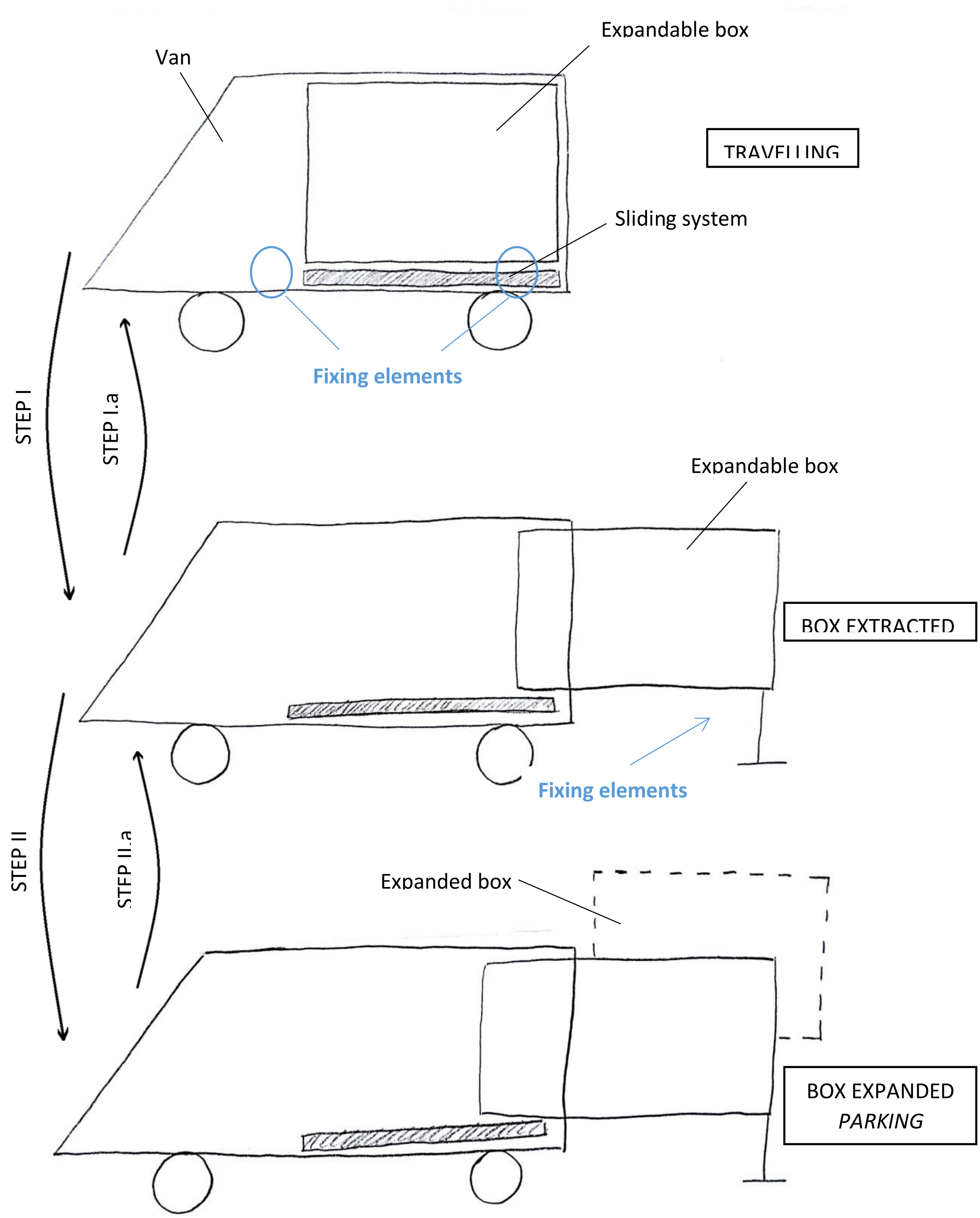


Fig. 1. Simplified graphical representation of the system to be designed

2 SURVEY OF THE EXISTING SOLUTIONS

One can find out several systems that are similar to the idea described above, but they don’t fulfill all the assumed requirements.

2.1 VOLKSWAGEN DOUBLEBACK

This van, as shown in Fig. 2., has an extensive back part inside with furniture on it. The extensive part will become the bedroom, leaving the rest of the vehicle for the kitchen and the leaving room. However, this is a really expensive model. Only the doubleback costs around 70000$, without taking into account the price of the van. Moreover, it only has two rotating seats with belts for passengers or, in the case that one needs three seats they don’t rotate.

Fig. 2. Volkswagen Doubleback[1] system

[1] All the information and prices are taken from the website [16] (Bibliography)

2.2 BETTMOBIL

It's a German product that, as the Fig. 3. shows, has an extra box added to the bottom part of the van with two beds inside. The sliding, folding bed module fits neatly inside the tailgate and sets up in a matter of minutes. The rest of the vehicle is developed as usual in this kind of vans without any significant innovation. The bed module costs €7,900 and a total camper package runs between €11,690 and €15,000, depending upon options selected.

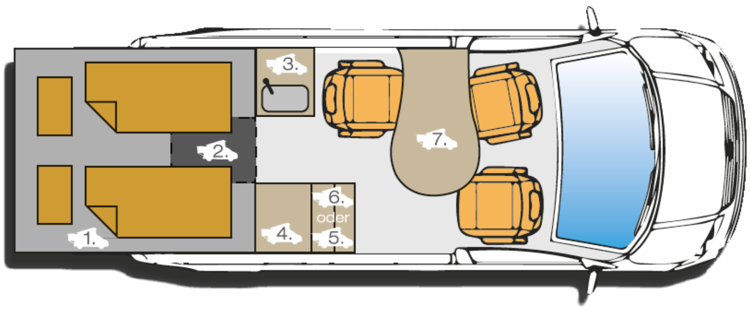


Fig. 3. Bettmobil[2] system

2.3 AUSTRIAN QUBIQ

This system is based in three main boxes, which are the cook, wash and cooler modules. The main advantage of the Qubiq is that one can add it or remove it from the car easily, each module mounts to the full-width accompanying base on the vehicle floor. The base secures easily to the vehicle with its two fasteners, and each module secures to the base inserts with simple click-in hardware. It's the most basic module that can be added to a car with more than a simple bed use. Prices start from €1,730 for the Camper Light set. Fig. 4. and Fig. 5. illustrate this system.

[2] All the information and prices are taken from the websites [18] and [19] (Bibliography)

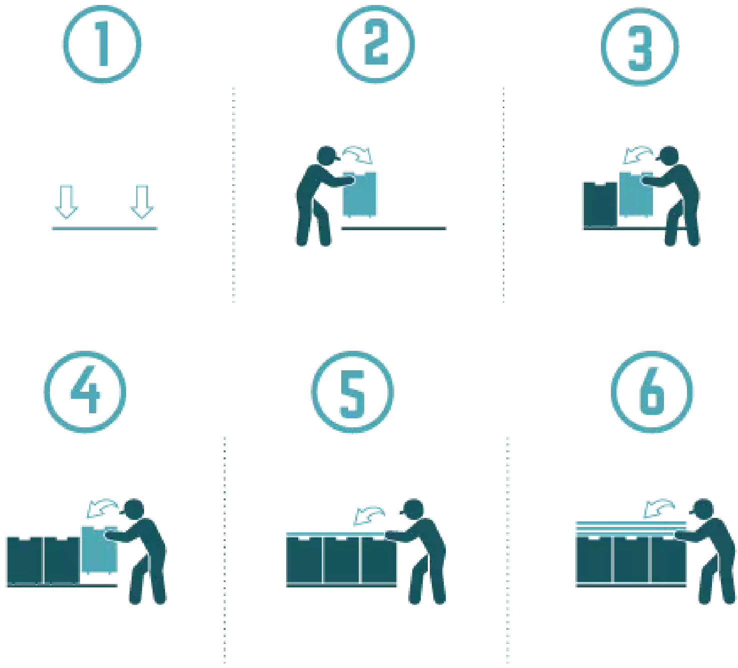


Fig. 4. Squematic representation of the Austrian Qubiq[3] system

Fig. 5. Austrian Qubiq system

[3] All the information and prices are taken from the website [17] (Bibliography)

3 ASSUMPTIONS FOR THE PROJECT

After making a survey of the existing solutions related to the project, there are some facts that can be improved.

The Doubleback is too expensive and it is only available for Volkswagen Transporter. On the other hand, the Qubiq is relatively cheap and easy to use, but not as comfortable for long trips as the Doubleback; it is a good option to travel during summer.

The other advantage of the Qubiq is that, unlike the Doubleback, it can be use in more than one model.

In a middle term we found the Bettmobil, that satisfies the price but it doesn't offer so much space as the Doubleback does. However, it also has the disadvantage of being available only for Volkswagen Transporter.

In the following sections will develop the facts that will be improved.

3.1 BLACK BOX

In the project can be recognized four main technical systems that are represented in Fig. 6, 7, 8 and 9.

Fig. 6. Pulling out the box

Fig. 7. Expanding the box

Fig. 8. Folding the box

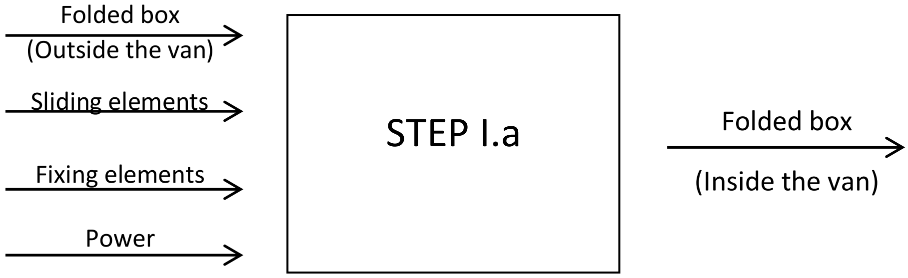


Fig. 9. Introducing the box in the van

The Fig. 6. shows the elements needed to move the box from inside the van to the outside; the opposite movement is shown in Fig. 9.

On the other hand, the Fig. 7. shows the ones needed for the expanding system (unfolding the box), while the Fig. 8. is the opposite one, the folding system.

The user should follow those steps in the order shown in the figures as schematized in Fig. 1.

3.2 DESIRES AND REQUIREMENTS

In the table 1 one can find the desires and requirements proposed. The requirements will be completely necessary to develop in the project, while the desires are not mandatory to be applied in the system to be designed.

Table 1. Desires and requirements

Date	Desire/Requirement	Description
29/02/2016	**Requirement**	**Cheaper than other existing solutions.** The market research shows that for a greatly increase of space in the van, the price is quite high.
29/02/2016	**Requirement**	**Adaptable to several vans.** Only one from the existing solutions found can be used in more than one model of van.
29/02/2016	**Requirement**	**Easy mounting.** With a previous assembly perform at the factory; the user should be able to assemble the rest of the parts by his own with some simple tools.
29/02/2016	**Requirement**	**Significant increase of the space of the van.** The increase of the space would make the stay more comfortable.
29/02/2016	**Desire**	**Use of solar panels.** In order to provide the energy needed to cook, charge some electrical devices or heat the space.
29/02/2016	**Desire**	**Include a sink with a small water tank.** It could be useful if the user needs water and cannot access to it by another way.
29/02/2016	**Requirement**	**Include folding furniture.** As the space while travelling is not as big as while camping, the furniture should be as small as possible.
04/03/2016	**Requirement**	**Expandable system as easy to use as possible.** It has to have a simple way to folding and unfolding the extendable system because, otherwise, the user will need to carry the instructions wherever he goes.
04/03/2016	**Desire**	**Lightweight.** The weight of the systems influences the fuel consumption and the easiness of use of it (the heavier the systems the more difficult to move it and the more fuel consumption).
04/03/2016	**Desire**	**Automate the mechanical systems.** To make it easier to extract the box from the van and unfold it.
04/03/2016	**Desire**	**Include seats in the back part of the van.** It would be more useful if, during the trip, inside the van could travel more than 2 or 3 passengers.
04/03/2016	**Desire**	**Use of insulated materials.** As the van could be used to travel, it would be better if the materials used to construct the box can keep the heat inside the van.

4 DESIGN ALTERNATIVES

According to the assumption that the designed system should get installed in different van-type vehicles, the dimensions of a number of vans have been investigated. Unfortunately, internal dimensions of vans vary greatly.

4.1 VAN MODELS

So, finally only ten different models from ten different car brands will be taken into account in order to achieve the assumed aim of being able to use this system in different vans[4]. Selected vans and their inside dimensions are the following ones[5]:

Table 2.Dimensions of selected vans

Van model	Max. Length [mm]	Max. Width [mm]	Width between Wheel Arches [mm]	Max. Height [mm]	Back door	
					Height [mm]	Width [mm]
Citroën Jumpy[6] 	2254	1600	1245	1449	1272	1237
Volkswagen Transporter 	2572	1700	1244	1410	1299	1473
Mercedes Benz Vito 	2586	1685	1270	1391	1261	1391

[4] The chosen vans are in the same wheelbase range of approximate 3m.
[5] Every picture and measure of the van models have been taken from the brochures that can be found in the websites from [2] to [12] (Bibliography)
[6] Badged Citroën Dispatch in some countries.

Iveco New Daily 	2620	1800	1317	1545	1450	1530
Opel Vivaro 	2415	1663	1268	1387	1320	1390
Peugeot Expert 	2254	1602	1250	1450	1272	1237
Renault Trafic 	2537	1662	1268	1387	1320	1368
Fiat Scudo 	2254	1600	1245	1449	1272	1237
Ford Transit Custom 	2555	1775	1390	1406	1340	1400
Toyota Proace 	2254	1600	1245	1449	1272	1237

As shown in the table 2, the values of the internal dimensions are similar (even equal in some models) so we estimate that it's possible to develop such a system that could fit in all of them.

Finally, the initial external dimensions of the box applicable in the 10 presented vans are shown in Fig. 10.

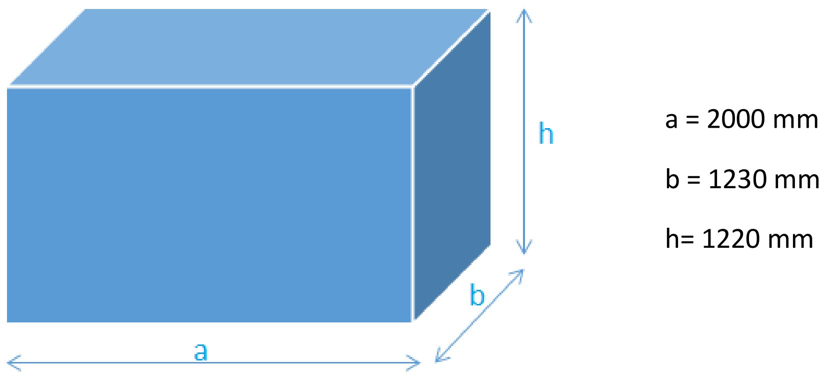


Fig. 10. Dimensions of the movable box

4.2 SLIDING SYSTEM[7]

Below, possible solutions of sliding system are presented. The sliding system enables to pull out and in the movable box.

4.2.1 DRAWER SYSTEM

A number of lateral telescopic guides are assembled to the van and also to the expandable part. However, such a solution possesses assembly problems. It is difficult to connect the guide to the van box. The vans have different shape of their walls. But once they are assembled it is really easy to use it, it's only needed to pull it out. Also it has the advantage of adapting to the terrain.

[7] In all the systems we assume that the box weight 1 ton but it's divided between both sides of the van, so in the calculations we'll take 500kg (5000N).

i. Sketches

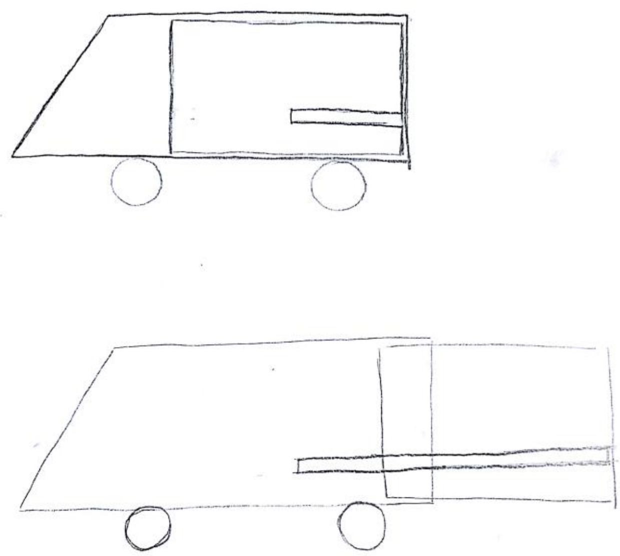


Fig. 11. Drawer system

ii. Simplified calculations

In order to check if this system is able to support a weight of 1 ton (10000 N), some simple calculations have been done.

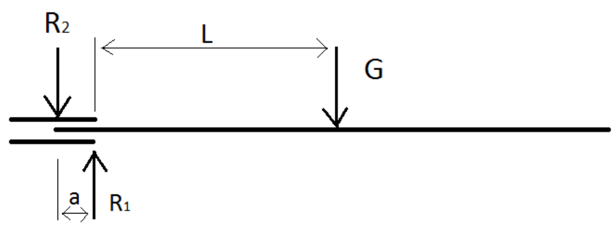


Fig. 12. Physical model for simplified calculations

$$\sum F_y = 0 \rightarrow G + R_2 = R_1$$

$$\sum M_{R_1} = 0 \rightarrow R_2 \cdot a = G \cdot L \rightarrow R_2 = \frac{G \cdot L}{a}$$

$$R_1 = 9700N$$

$$R_2 = 4700N$$

Knowing that a=800 and L=752.

iii. Products

It was required looking for the products needed to perform this system in order to know the average price of it. Some telescopic guides that are able to support this load were found. It would be needed 5 of them in each of the lateral parts and it can expand 1.5m; each one supports 220kg and weights 14.60 kg.

Length (mm)	Extension (mm)	Capacity load <10k cycles	Reference	pair weight
1500.00	1504.00	220.00 Kg.	114-S15	14.60 Kg.

Fig. 13. Example of telescopic guide

The prices are:

- *Telescopic guides(Fig. 13.*[8]*):* 386.5 € each pair

The approximate total price is 1932.5 €. It is really expensive system. Its price results from the required size and load capacity (they have to withstand a load of 1 ton). Another problem is that it is required a good inspection and if they broke, the reparation would be rather expensive.

4.2.2 RAILS SYSTEM 1

In this case two rails are extended to the outside and fixed to floor with a support. The expandable part has four wheels in the bottom; two are located in the front part and the other two in the back one. So once the rails are fixed the expandable part is pulled to the outside without any problem. The rails are able to keep fixed the box during travelling, so it is really safe. Mounting this system doesn´t need great skills, it is simple.

[8] Images taken from website [14] (Bibliography)

i. <u>Sketches</u>

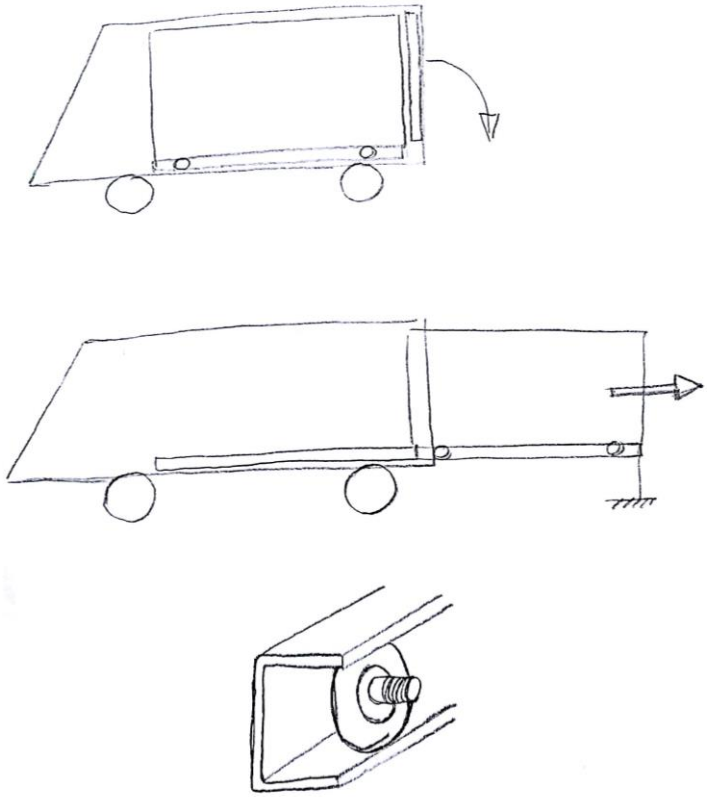


Fig. 14. Rails system 1

ii. <u>Simplified calculations</u>

In order to check if this system is able to support a weight of 1 ton, we've made some simple calculations.

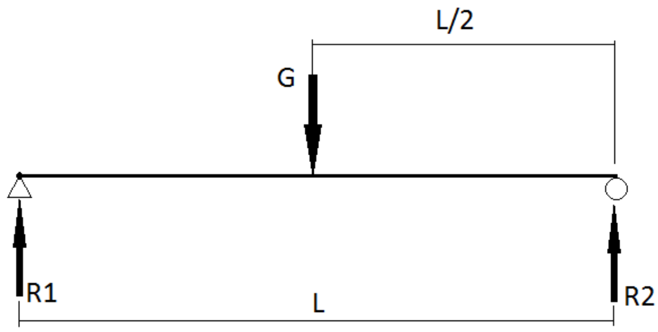


Fig. 15. Physical model for simplified calculations

$$\left.\begin{aligned} &\sum F_y = 0 \rightarrow R_1 + R_2 = G \\ &\sum M_{R_1} = 0 \rightarrow G \cdot \frac{L}{2} = R_2 \cdot L \rightarrow R_2 = \frac{G}{2} \end{aligned}\right\} \quad R_1 = R_2 = \frac{G}{2}$$

Each of the supports needs to be able to lift half of the weight distributed through the rail. Due to the fact that we have two rails and the weight is split evenly, each of the wheels has to support 250 kg.

iii. Products

We've looked for the products needed to perform this system in order to know the average price of it. In this case four wheels, four rails and two fixed supports are needed. The four rails support at least 2,5 KN each and have a length of 2 m each of them.

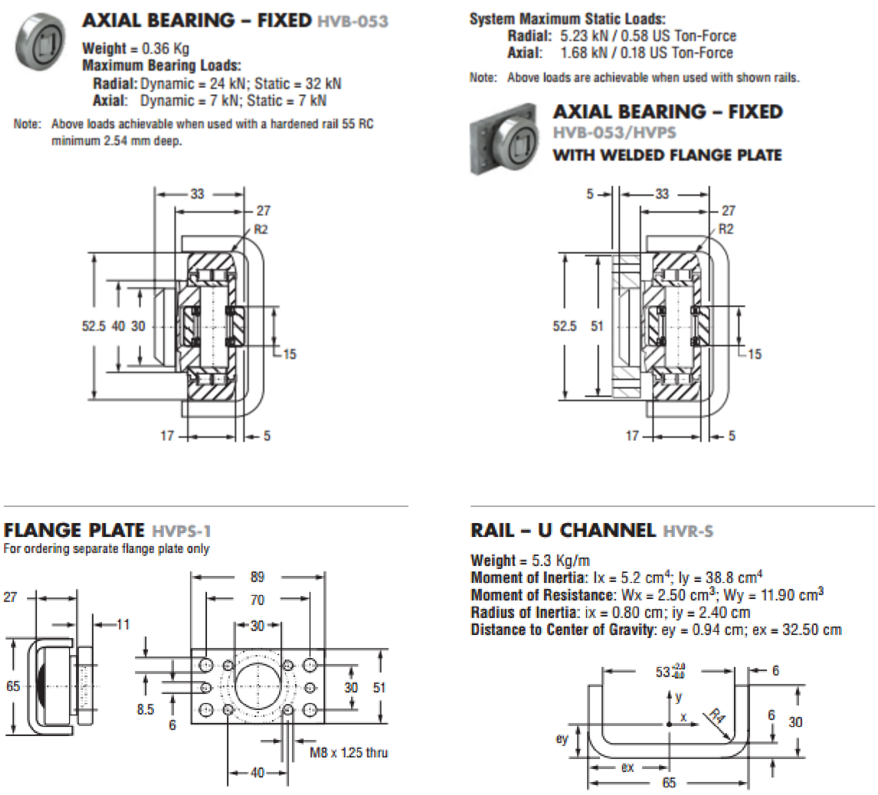


Fig. 16 a. Exemplary sample components of rail system

Fig. 16 b. Exemplary sample components of rail system

The prices are:

- *Rails (Fig. 16 a.)*: 80 € each
- *Wheels*[9] *(Fig. 16 a.)*: 19 € each
- *Fixed support(Fig. 16 b.)*: 15-30 € each

The approximate total price will be 440 €. It has quite a good price and the maintenance wouldn´t be a big problem, because the material used is fabricated for a long life.

4.2.3 RAILS SYSTEM 2

In another solution related to the rail system (presented in Fig.17.) there are three roller wheels in one side, so this rollers support all the weight of the box. In this case it is needed just rails fixed to the van, we don´t need extra rails in the outside. The sketches are as following:

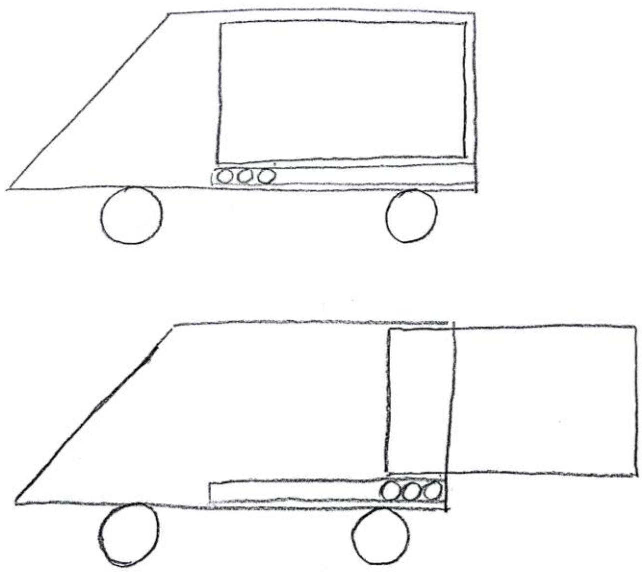


Fig. 17. Rails system 2

iv. Simplified calculations

In order to check if this system is able to support a weight of 1 ton, some simple calculations have been performed.

[9] Images taken from website [26] (Bibliography)

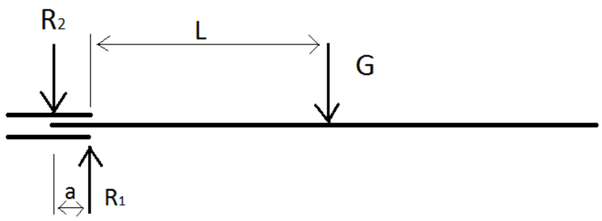


Fig. 18. Physical model for simplified calculations

$$\sum F_y = 0 \rightarrow R_1 = G + R_2$$

$$\sum M_{R_1} = 0 \rightarrow G \cdot L = R_2 \cdot a \rightarrow R_2 = \frac{G\,L}{a}$$

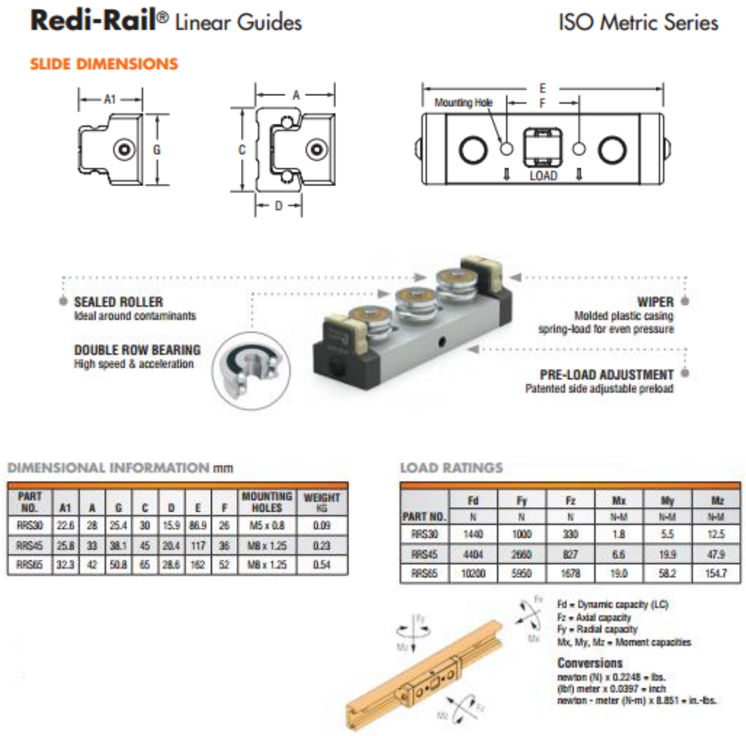
$$R_1 = 91.5\ kN$$

$$R_2 = 86.5\ kN$$

Each of the linear guides has to support, at least 91500 kN.

v. <u>Products</u>

It was necessary to look for the products needed to perform this system in order to know the average price of it. In this case, with the product that we have found (Fig. 19.), 10 linear guides in each side of the van would be needed to support the weight, so this system is not viable.



DIMENSIONAL INFORMATION mm

PART NO.	A1	A	G	C	D	E	F	MOUNTING HOLES	WEIGHT KG
RRS30	22.6	28	25.4	30	15.9	86.9	26	M5 x 0.8	0.09
RRS45	25.8	33	38.1	45	20.4	117	36	M8 x 1.25	0.23
RRS65	32.3	42	50.8	65	28.6	162	52	M8 x 1.25	0.54

LOAD RATINGS

PART NO.	Fd	Fy	Fz	Mx	My	Mz
	N	N	N	N-M	N-M	N-M
RRS30	1440	1000	330	1.8	5.5	12.5
RRS45	4404	2660	827	6.6	19.9	47.9
RRS65	10200	5950	1678	19.0	58.2	154.7

Fig. 19. Exemplary sample components of rail system

4.2.4 GUIDE SYSTEM

Two guides are assembled to the floor of the van, each guide has two carriages. The four carriages are screwed to a plate which is assembled with the expandable part. Once this part is out, the carriages are enough to support the weight. This system is really safe, during travelling wouldn´t be any movement of the box. It does not involve problems with any kind of terrain. However, such solution has at least the following disadvantages:

- Difficult, precise assembly procedure
- Maintenance problems

i. Sketches

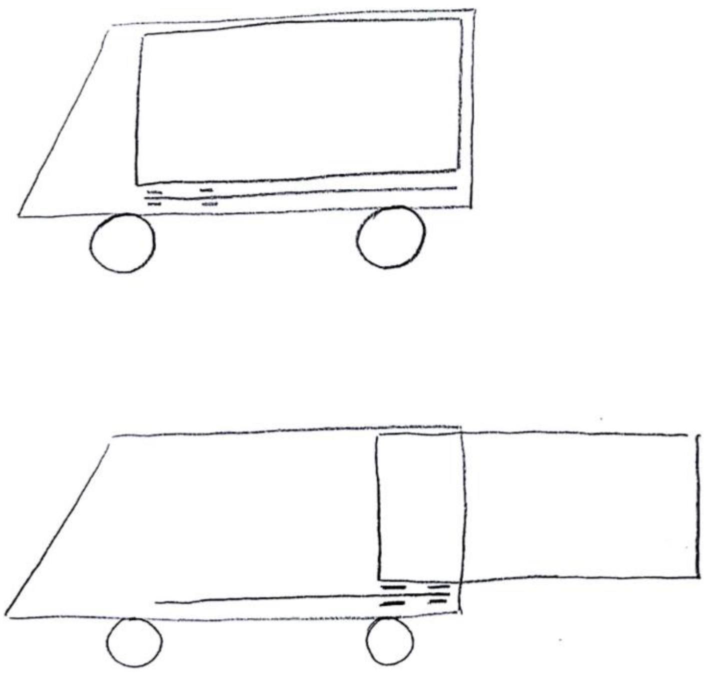


Fig. 20. Guide system

ii. Simplified calculations

In order to check if this system is able to support a weight of 1 ton, we've made some simple calculations.

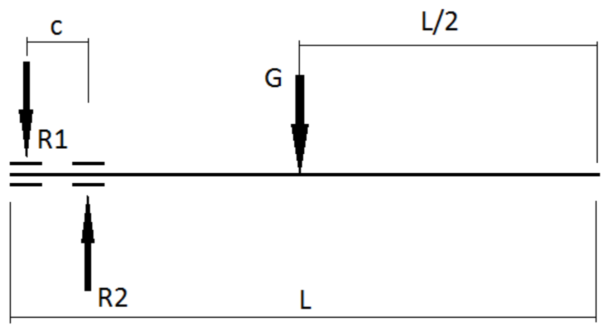


Fig. 21. Physical model for simplified calculations

$$\sum F_y = 0 \rightarrow R_1 + R_2 = G$$

$$\sum M_{R_1} = 0 \rightarrow R_2 \cdot c = G \cdot \frac{L}{2}$$

Taking into account that in this case the values for the unknowns are:

$$c = 0{,}1\ m; L = 2\ m; G = 500\ kg$$

The weight is half a ton due to there will be two guides under the box supporting the whole load.

The resulting values are:

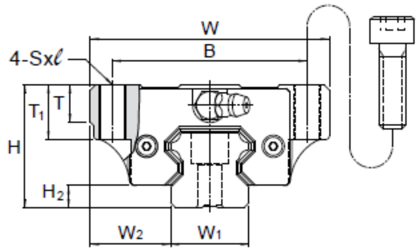
$$R_1 = \ -45000\ N\ ; R_2 = 50000\ N$$

iii. Products

We've looked for the products needed to perform this system in order to know the average price of it. Two rails and four carriages are needed for this system. The two rails have a length of 2 m, and the carriages needs to support at least 50 KN each of them. These kinds of elements are used in manufacturing processes where big quality of products is absolutely necessary.

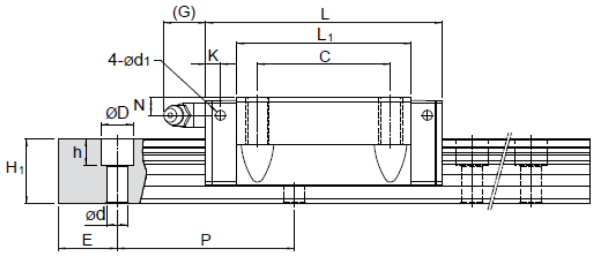
Fig. 22.[10] presents exemplary guide system.

[10] Images taken from website [25] (Bibliography)



Unit: mm

Model No.	Rail dimension					Basic load rating		Static moment rating					Weight	
	Width W_1	Height H_1	Pitch P	E std.	D×h×d	Dynamic C kN	Static C_o kN	M_P kN-m Single*	M_P kN-m Double*	M_Y kN-m Single*	M_Y kN-m Double*	M_R kN-m	Carriage kg	Rail kg/m
MSA 15 A	15	15	60	20	7.5×5.3×4.5	11.8	18.9	0.12	0.68	0.12	0.68	0.14	0.18	1.5
MSA 20 A MSA 20 LA	20	18	60	20	9.5×8.5×6	19.2 23.3	29.5 39.3	0.23 0.39	1.42 2.23	0.23 0.39	1.42 2.23	0.29 0.38	0.4 0.52	2.4
MSA 25 A MSA 25 LA	23	22	60	20	11×9×7	28.1 34.4	42.4 56.6	0.39 0.67	2.20 3.52	0.39 0.67	2.20 3.52	0.48 0.63	0.62 0.82	3.4
MSA 30 A MSA 30 LA	28	26	80	20	14×12×9	39.2 47.9	57.8 77.0	0.62 1.07	3.67 5.81	0.62 1.07	3.67 5.81	0.79 1.05	1.09 1.43	4.8
MSA 35 A MSA 35 LA	34	29	80	20	14×12×9	52.0 63.6	75.5 100.6	0.93 1.60	5.47 8.67	0.93 1.60	5.47 8.67	1.25 1.67	1.61 2.11	6.6
MSA 45 A MSA 45 LA	45	38	105	22.5	20×17×14	83.8 102.4	117.9 157.3	1.81 3.13	10.67 16.95	1.81 3.13	10.67 16.95	2.57 3.43	2.98 3.9	11.5



Unit: mm

Model No.	External dimension					Carriage dimension										
	Height H	Width W	Length L	W_2	H_2	B	C	S×ℓ	L_1	T	T_1	N	G	K	d_1	Grease Nipple
MSA 15 A	24	47	56.3	16	4.2	38	30	M5×11	39.3	7	11	4.3	7	5.7	3.3	G-M4
MSA 20 A MSA 20 LA	30	63	72.9 88.8	21.5	5	53	40	M6×10	51.3 67.2	7	10	5	12	5.8	3.3	G-M6
MSA 25 A MSA 25 LA	36	70	81.6 100.6	23.5	6.5	57	45	M8×16	59 78	11	16	6	12	5.8	3.3	G-M6
MSA 30 A MSA 30 LA	42	90	97 119.2	31	8	72	52	M10×18	71.4 93.6	11	18	7	12	6.8	3.3	G-M6
MSA 35 A MSA 35 LA	48	100	111.2 136.6	33	9.5	82	62	M10×21	81 106.4	13	21	8	11.5	8.6	3.3	G-M6
MSA 45 A MSA 45 LA	60	120	137.7 169.5	37.5	10	100	80	M12×25	102.5 134.3	13	25	10	13.5	10.6	3.3	G-PT1/8

Fig. 22. Exemplary sample components of guide system

The prices are:

- *Rails (Fig. 22.):* 177 € each
- *Carriages (Fig. 22.):* 50 € each

The approximate total price will be 554 €. The problem of this system is the maintenance, if some of the parts broke, the replacement would be expensive. This system needs a good lubrication and it implicates some maintenance problems.

4.2.5 WHEELS SYSTEM

In this solution, two wheels are placed at the extreme of the expandable part, so they are the first of being out. Once they are on the floor, it is possible to pull to the outside, without any problem referring to the surface of the floor, the expandable part. The box is fixed with latches inside the van while travelling, if not it would be moving and it is really dangerous.

Moreover, this system is rather easy to mount, so everyone can do it. And the maintenance doesn´t mean a problem, replace its parts is not difficult and they are relatively cheap.

i. <u>Sketches</u>

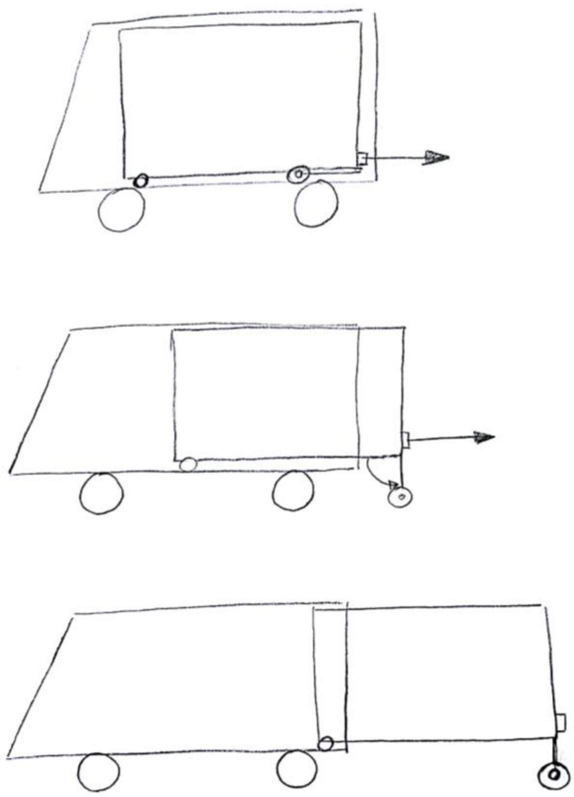


Fig. 23. Wheels system

ii. <u>Simplified calculations</u>

In order to check if this system is able to support a weight of 1 ton, some simple calculations have been performed.

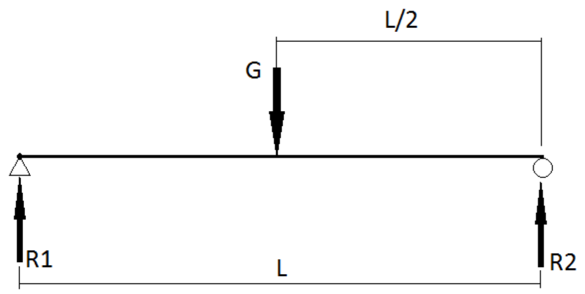


Fig. 24. Physical model for simplified calculations

$$\left.\begin{aligned}&\sum F_y = 0 \rightarrow R_1 + R_2 = G\\&\sum M_{R_1} = 0 \rightarrow G \cdot \frac{L}{2} = R_2 \cdot L \rightarrow R_2 = \frac{G}{2}\end{aligned}\right\} \quad R_1 = R_2 = \frac{G}{2}$$

Each of the supports needs to be able to lift half of the weight distributed through this side. Due to the fact that we have one wheel in each of the corners of the box and the weight is split evenly, each of them has to support 250 kg.

iii. Products

Exemplary components of wheels system is presented in Fig. 25. This system uses two small wheels and two wheels with adjustable height. Each wheel support 250 kg, the diameter of the smaller wheels is 10 cm and for the bigger one it is 23 cm.

1) Max lift load capacity: 1000LBS

2) Travel height: 230mm

3) Outer /inner tube shape: Ø70x70.mmsquare tube/ Ø60.mm tube

4) Wheel size: 230X75MM rubber wheel metal rim

5) Galvanized outer tube, galvanized inner tube

Fig. 25 a. Exemplary sample components of wheels system

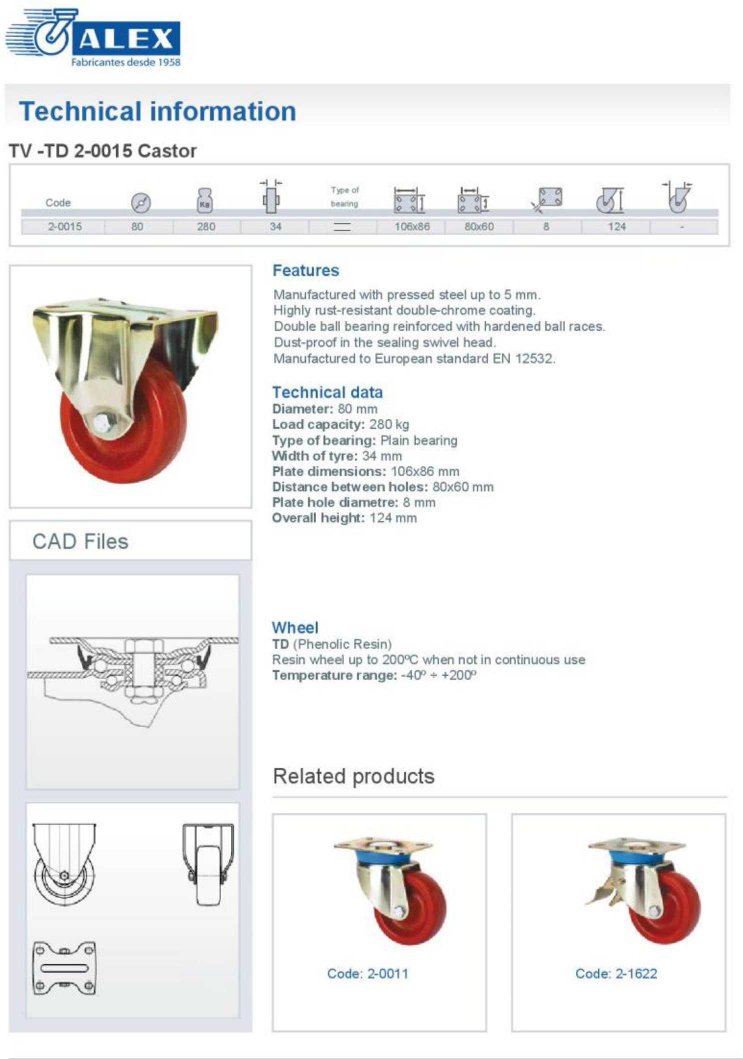


Fig. 25 b. Exemplary sample components of wheels system

The prices are:

- *Small wheels*[11] *(Fig. 25 b.)*: 14.55 € each
- *Big wheels (Fig. 25 a.)*: 10-30 € each

The approximate total price is 67 €. As we can see this system is really cheap. One problem is about moving the wheels in a difficult terrain because they can break. Another problem is to fix them at a standstill, so the wheels must be equipped with a break system.

[11] Images taken from the website [13] (Bibliography)

4.2.6 FOLDING TABLES

In this concept, two tables are placed at the end of the back part; those tables are folded to the outside and fixed to the floor with an adjustable support. Once they are fixed, the expandable part, which has four wheels, is pulled to the outside by the user and fixed to the table using latches in order to avoid any movement while it is used. The same mechanism is used to fix it inside the van while travelling. Also, in order to make it safer, the floor inside the van has two small slots where wheels are placed. With these two slots, sliding movement of the box while travelling is avoided.

An important advantage of this system is that it is easy to use and mount. The life of this is not a problem because it does not ask for high quality materials, so it would be cheap too.

i. <u>Sketches</u>

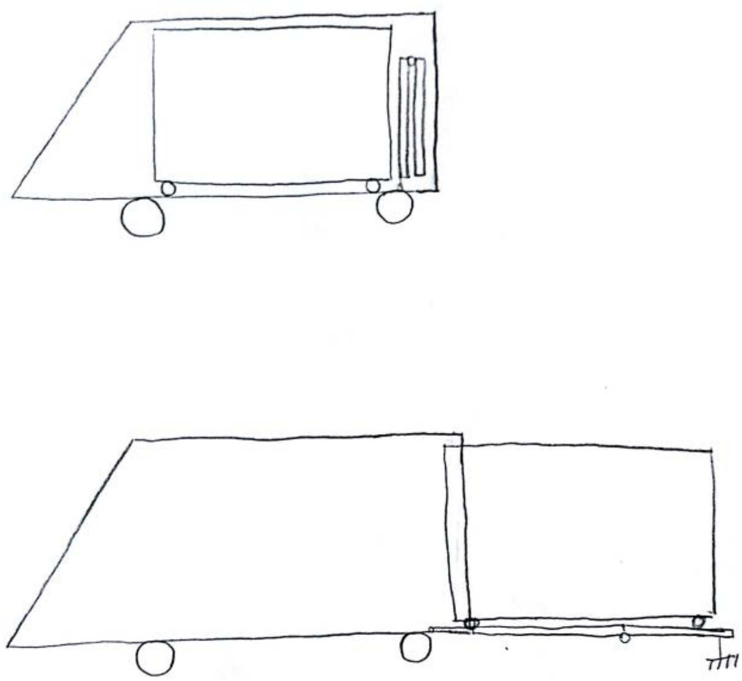


Fig. 26. Folding tables system

ii. <u>Simplified calculations</u>

In order to check if this system is able to support a weight of 1 ton, we've made some simple calculations.

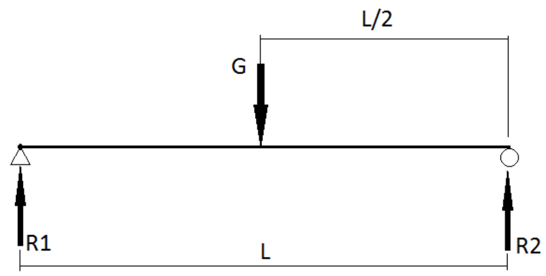


Fig. 27. Physical model for simplified calculations

$$\sum F_y = 0 \rightarrow R_1 + R_2 = G$$

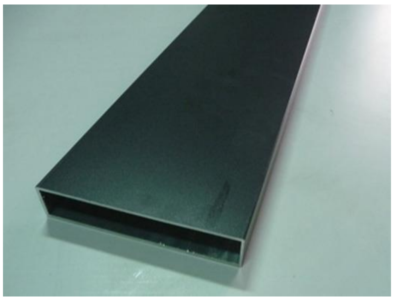
$$\sum M_{R_1} = 0 \rightarrow G \cdot \frac{L}{2} = R_2 \cdot L \rightarrow R_2 = \frac{G}{2}$$

$$R_1 = R_2 = \frac{G}{2}$$

Each of the supports needs to be able to lift half of the weight. Due to the fact that we have two folding tables and the weight is split evenly, each of the wheels has to support 250 kg.

iii. Products

We've looked for the products needed to perform this system in order to know the average price of it. It has four small fixed wheels, two folding tables and two fixed supports. The diameter of the wheels is 10 cm and the length of the folding tables is 1 m each of them.



Material: Aluminum

Thickness: 5 mm

Length: 1 m

Height: 30 mm

Width: 250 mm

Fig. 28. Exemplary sample components of folding tables system

The prices are:

- *Small wheels(Fig. 25 a.)*: 14.55 € each
- *Folding tables (Fig. 28.)*: 1-5 €/ kg
- *Fixed supports(Fig. 16 b.)*: 15-30 € each

The approximate total price will be 238.2 €. It has a balanced price and, what is important, every part is easy to replace and cheap.

4.3 EXPANDABLE SYSTEM

Expandable system of movable box gives the possibility of an additional extension of usable space. The dimensions of the main box will be the same for all the models but, when the van is completely extracted to the outside, its walls will open to offer more space.

In this chapter, a number of possible solutions of extendable system are presented.

4.3.1 ADAPTABLE SYSTEM

General idea of is solution is presented in Fig. 29. The expansions are not big; the initial dimension of the box would be the one of the smallest van (see chapter 4.1). The range of expansion would be from the smallest to the biggest[12]. The expansion of the walls can be done inside the van or outside, as there is a part of the box that will be kept inside the van, so it is the same wherever it is done. This expansion is uniform and will depend on the measures of the van.

I. Sketches

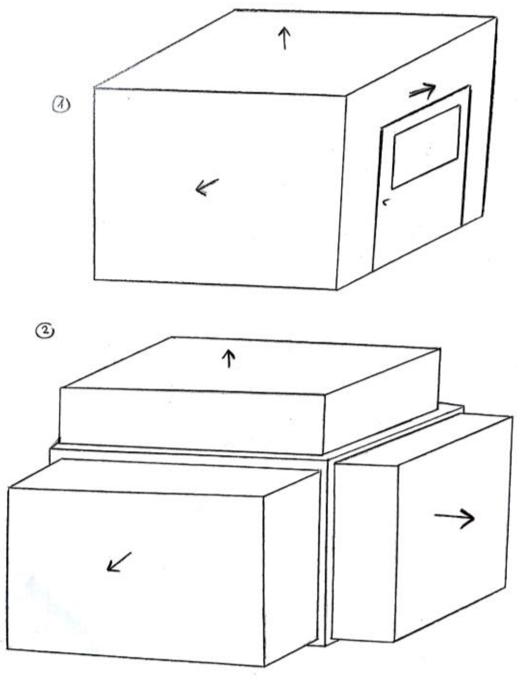
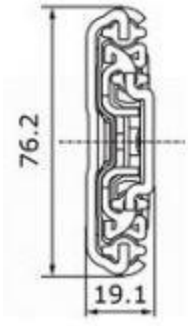


Fig. 29. Sketch of adaptable system

[12] The dimensions of the vans are specified in a previous headland.

II. Products

The adaptable system in the form presented in Fig. 29. requires the use of some telescopic guides, examples of which are presented in Fig. 30 a.



Length (mm)	Extension (mm)	Capacity load <10k cycles	pair weight
500.00	512.00	260.00 Kg.	4.80 Kg.

Fig. 30 a. Exemplary sample components of adaptable system

Additionally, such expanding system requires the use of a number of composite plates. Exemplary ones are presented in Fig. 30 b.

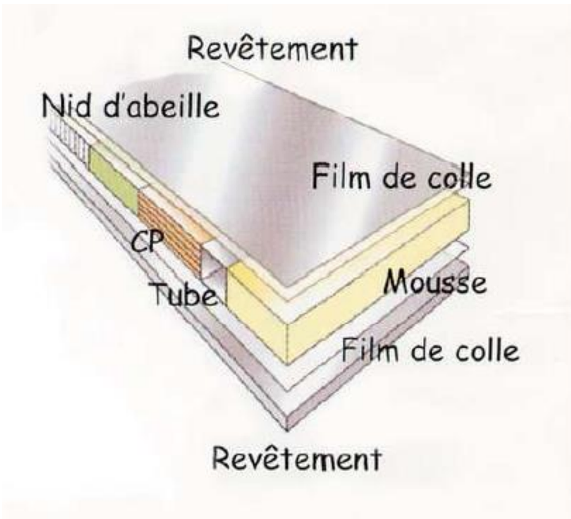


Fig. 30 b. Exemplary sample components of adaptable system

The prices are:

- *Guides (Fig. 30 a.)*: 164.90 € each
- *Composite panels (Fig. 30 b.):* 5.5-16 €/ u

The approximate total price will be 1151.4€.

4.3.2 ACCORDION SYSTEM

In this concept, shown in Fig. 31., the walls of the box will be folded until some supports attached to the ground. While folded, a structure made of polymers and some bars made of metal (like an accordion) will appear given us more space to be in. The accordion system allows us to move just the floor, adjusting to the desire height the structure of polymers and bars. It does not need any window because of the transparent polymers.

I. Sketches

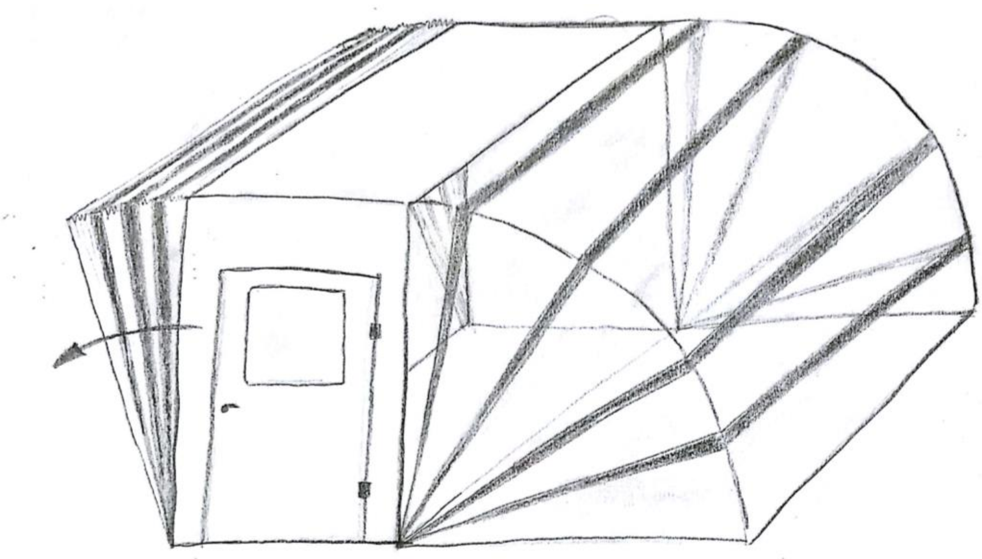


Fig. 31. Accordion system

II. Products

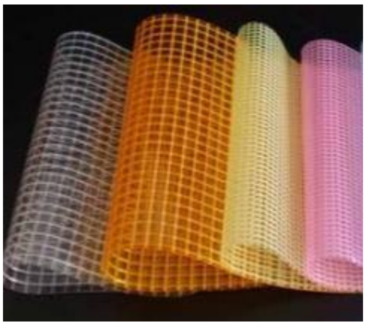
It was necessary to look for the products needed to perform this system in order to know the average price of it. In this system will need 24 tubes, 16 joints, 4 fixed supports and around 6m of mesh.

Thickness: 0.5-150mm

Outer Diameter: 2-2500mm

合金种类 Alloy		化学成份 (Chemical Composition)									
		Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Others	Al (Min)
7075	AlZn6MgCu	0.4	0.5	1.2-2.0	0.3	2.1-2.9	0.18-0.28	5.1-6.1	0.2	0.15	Remainder

Fig. 32 a. Exemplary sample components of accordion system



1. Hot-melt Coating technology (Semi-coating).
2. Good peeling strength for welding.
3. Outstanding tearing strength.
4. Flame retardant character (optional)
5. Anti ultraviolet treatment (UV) (optional)
6. Acrylic treatment (optional).
7. Temperature resistance: -20~70°C

Fig. 32 b. Exemplary sample components of accordion system

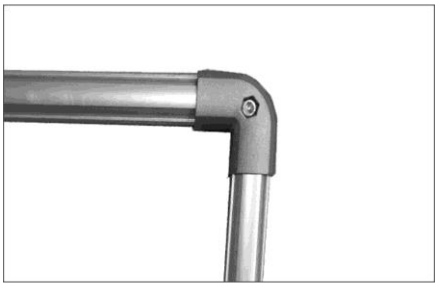


Fig. 32 c. Exemplary sample components of accordion system

The prices are:

- *Aluminum tubes (Fig. 32 a.)*: 0.99 – 3.59 €/kg
- *PVC transparent mesh (Fig. 32 b.):* 1.5 – 3 €/kg
- *Joints (Fig. 32 c.):* 0.15 – 10.15 € each
- *Fixed supports (Fig. 16 b.):* 20 € each

The approximate total price will be 161.6 €. It is a cheap system without problems with replacing parts that are broken and they can be replaced by the user easily.

4.3.3 TENT SYSTEM

As in the previous system, the walls of the box will be folded until some supports attached to the ground. However, in this case the structure is completely made of polymer or other kind of fabric that will be supported by some bars inside it. It gives a lot of additional space, but when it is not expanded, it occupies space inside the box.

I. Sketches

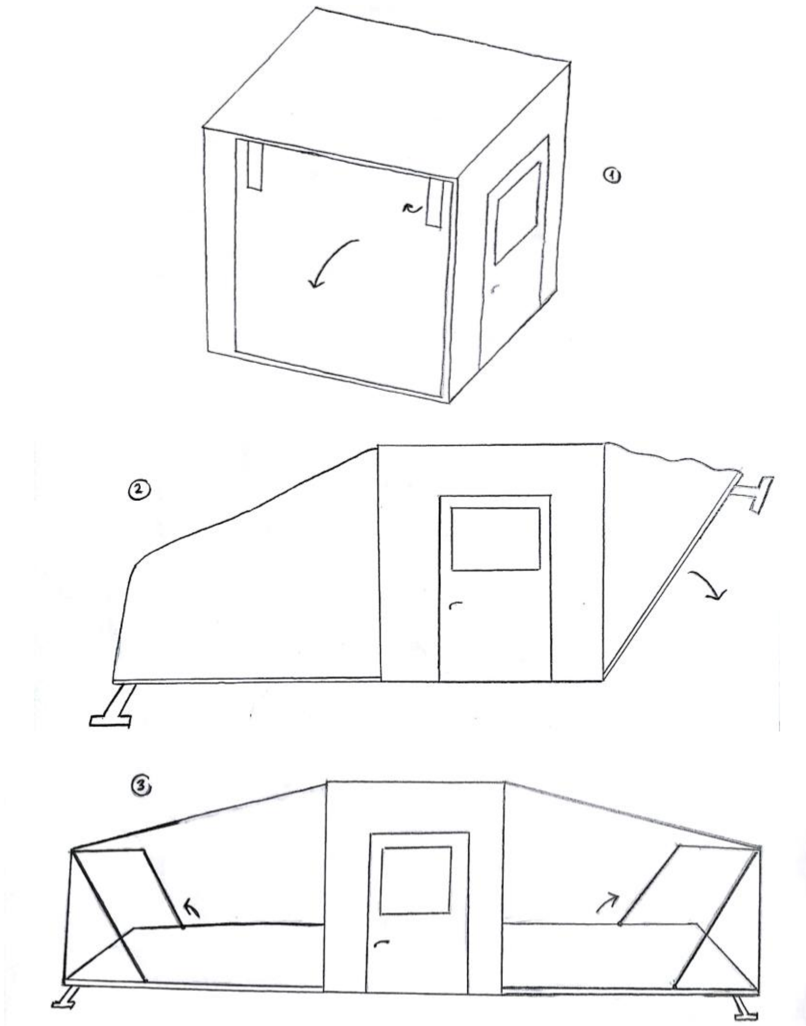


Fig. 33. Tent system

II. Products

We've looked for the products needed to perform this system in order to know the average price of it. In this system will need about 7 m of PVC tarps, 6 aluminum tubes, 4 joints and 4 fixed supports.

Material: PE/PP

Weight: 65 to 280 g

Width: 1-12 m

Function: waterproof, weather resistant, sun proof

Fig. 34. Exemplary sample components of tent system

The prices are:

- *PVC tarps (Fig 34.):* 1 - 30 €/m
- *Aluminum tubes (Fig. 32 a.):* 0.99 – 3.59 €/kg
- *Joints (Fig. 32 c):* 0.15 – 10.15 € each
- *Fixed supports(Fig. 16 b.):* 20 € each

The approximate total price will be 208.5 €.

4.3.4 FOLDING SYSTEM

In this case, the walls of the box will comprise several lays of metal that will be unfolded creating two more “rooms” inside our box. This system gives more space than the others and is really easy to mount just following several steps. One advantage is that when it is closed, it doesn´t occupy space, so it is also possible to use.

I. <u>Sketches</u>

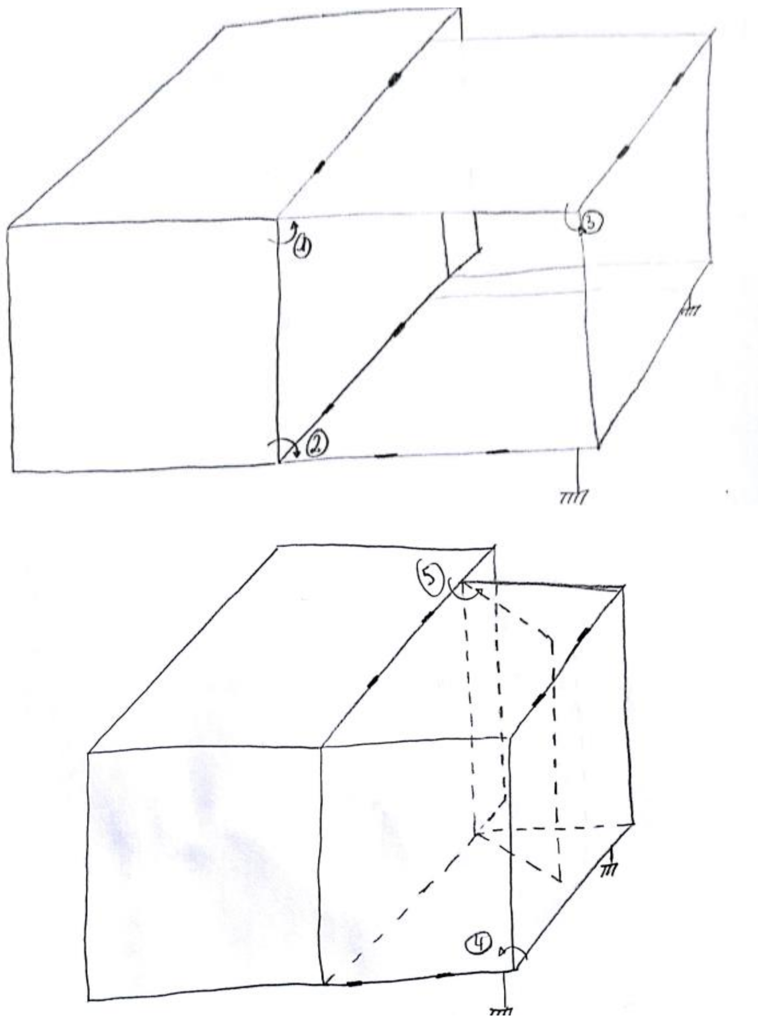


Fig. 35. Folding system

II. Products

It was necessary to look for the products needed to perform this system in order to know the average price of it. In this system it will be needed 10 more metal plates and 4 fixed supports.

The prices are:

- *Metal plates (Fig. 30 b.):* 3.5-17.8 €/ m^2
- *Fixed supports (Fig. 16 b.): 20 € each*

The approximate total price will be 250 €.

4.3.5 PULLOUT SYSTEM

The walls of the van are taken outside until some supports with some guides. In this case, the whole part (floor, walls and roof) are moved to obtain more space. And it hasn´t any support, just guides are enough to support the weight.

This system imitates the system used in some caravan and also trailers. It is more complex to mount than the others, so maybe it is needed some skills for its mounting.

I. Sketches

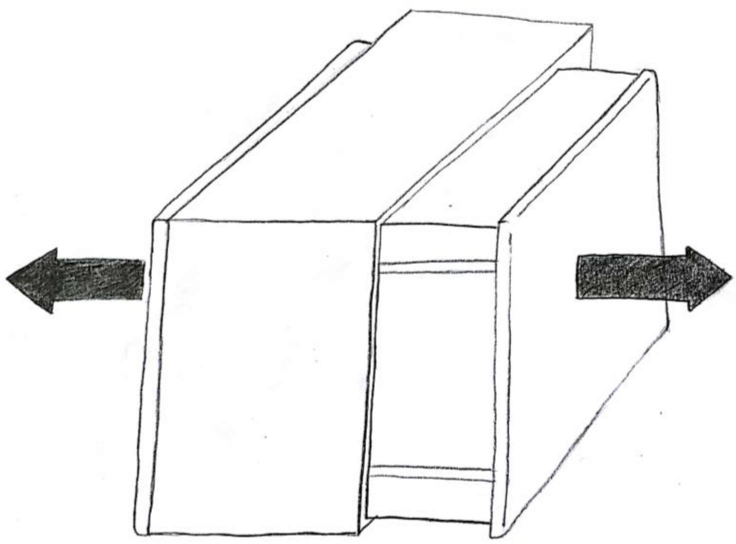


Fig. 36. Pullout system

II. Products

We've looked for the products needed to perform this system in order to know the average price of it. We need 4 guides and 8 more "walls" to perform this system.

Length (mm)	Extension (mm)	Capacity load <10k cycles	pair weight
1000.00	1000.00	300.00 Kg.	9.80 Kg.

Fig. 37. Exemplary sample components of pullout system

The prices are:

- *Guides (Fig. 37.):* 344.3 € each
- *Metal plates* (*Fig. 30 b.*): 3.5-17.8 €/ m^2

The approximate total price will be 1588 €. In this case the system is rather expensive.

4.4 SELECTION OF SYSTEMS

In order to make a proper selection of one of the alternatives presented above an evaluation procedure has been applied.

In this procedure several aspects of interest related to each of the proposals have been taken into account.

Weighting selected aspects in order of importance, an overall score for each of them is obtained.

In such way it was possible to choose the proposal with a higher overall rating for each of the systems to carry out.

4.4.1 LIST OF EVALUATED ASPECTS

The aspects evaluated are the following ones:

- Price: The market research shows that for a greatly increase of space in the van, the price is quite high, so it is a very important factor for our project. An improvement of this characteristic compared with the other models found is wanted.
- Easy mounting: With a previous assembly perform at the factory; the user should be able to assemble the rest of the parts by his own with some simple tools. If the assembly is not completely done in the factory, it will reduce the cost of manufacture.
- Easy to use: It has to have a simple way to folding and unfolding extendable system, as well as a simple use of the extracting system, because, otherwise, the user will need to carry the instructions wherever he goes and this is a tedious task.
- Life: This kind of products are supposed to have a relatively long life, due to they are not quite cheap and users don't change them each year; so a system that will deteriorate in a short time is not wanted.
- Maintenance: If one of the parts or the whole system is damage and the user has to change it, is better if it can be changed by his own and is as cheaper as possible than if you have to go to the repair workshop and they have to change it.
- Adaptable to the terrain: As this system has been developed with the idea of increasing the living space of vans used to travel, it must be able to adapt to as many potential sites as possible, because this kind of vans are usually use to camp in sites with irregular soil.
- Power (Force): the force needed to use the system must be taken into account. As we are going to design it to be possible to use it, it is easier for the users if they don't need to perform so much force.
- Safety in adverse conditions: the difficulties to take this system out if there's so much wind or the floor is unstable are taken into account.

- Weight: The weight of the systems influences the fuel consumption and the easiness of use of it (the heavier the systems the more difficult to move it and the more fuel consumption). It required a system as light as possible, so the weight while travelling doesn´t increase.
- Space given: it's an important factor in the expandable box systems.

4.4.2 WEIGHTAGES

In the selection of the systems that are going to be use in each case, weightages to each of the evaluated aspects described before are given. Not all of them are used to evaluate both systems, but the ones that are used in both of them have the same weightage.

- Price: as this is one of the most important aspects for us, its weightage is going to be 10.
- Easy mounting: the assembly of the systems is an important fact for the price (if it's so difficult to perform it, most part of it will be done at the factory increasing the price) and for the user, that should be able to mount it and dismount it from the van, so its weightage is an 8.
- Easy to use: in order not to have a really tedious task when camping, it's also important this aspect when evaluating the different systems, so it also has a weightage of 8.
- Life: this aspect is not very important, but it is taken into account due to it is not wanted a system that lasts so little time. Its weightage is a 5.
- Maintenance: it's evaluated as we don't want high value components that, if they break, the price of the part and the change of it wouldn't be so expensive and tedious for the user. The weightage is a 3.
- Adaptable to the terrain: if the system is not able to adapt correctly to many terrains, it wouldn't be used in so many places so it's a really important aspect with a weightage of 8.
- Power: if the force needed to use the selected system is too high, it would be possible to install a motor to apply this force so, as the most important for this is the price added if the motor is needed, the weightage is a 3.

- Safety in adverse conditions: the security of the systems if the conditions are not the best ones it's a very important aspect, so, as for the mounting and use, the weightage in this case is also an 8.
- Weight: As we explain in the previous headland, it's an important fact related to the use and the fuel consumption, so we assign a weightage of 7 to this aspect.
- Space given: this aspect is only evaluated in the expandable system, and as this is also of great importance, so its weightage is 10.

For making a properly selection of the systems, the percentages given to each of the evaluated aspects have also been changed.

In the case of the sliding system, the general percentage if we divide the 100% between the 9 aspects will 11% but if we give a 35% for the price and the easiness of use, and a 65% for the rest of aspects, the first two will receive a 17,5% so they have a greater importance for the final result, and the rest of them will have a 9,3%.

For the expandable system, the initial percentage will be 14,3% and, after applying the other percentages for the same aspects than before, the price and the easiness of use will have a 17,5% and the rest of them a 13%.

The formulas used are the following ones:

$$\frac{35}{100} \times \frac{Grade}{\sum Grades_{0.35}}$$

$$\frac{65}{100} \times \frac{Grade}{\sum Grades_{0.65}}$$

4.4.3 GRADES RELATED TO DIFFERENT CONCEPTS

In the following tables we can see the grades given for each of the systems to the aspects presented above.

Table 3. Sliding system evaluation

Grades assumed

ALTERNATIVES		DRAWER SYSTEM	RAILS SYSTEM	GUIDE SYSTEM	WHEELS SYSTEM	FOLDING TABLES SYSTEM
CRITERIA	WEIGHTAGE					
Price	0,194444444	1	5	4	8	7
Easy mounting	0,123809524	4	7	3	9	9
Adaptable to the terrain	0,123809524	9	9	10	7	9
Life	0,077380952	7	7	7	9	9
Maintenance	0,046428571	7	7	3	8	7
Easy to use	0,155555556	10	9	10	9	8
Power	0,046428571	5	6	10	4	6
Safety in adverse conditions	0,123809524	4	8	7	6	8
Weight	0,108333333	7	7	5	7	6
Relevant information						
Average		6	7,222222222	6,555555556	7,444444444	7,666666667
Normalized weighted average		0,571190476	0,724722222	0,649642857	0,769126984	0,777460317

Normalized weightages

Final results

Price	10
Easy mounting	8
Easy to use	8
Life	5
Maintenance	3
Adaptable to the terrain	8
Power	3
Safety in adverse conditions	8
Weight	7

Initial weightages

Table 4.Expandable system evaluation

ALTERNATIVES		ADAPTABLE SYSTEM	ACCORDION SYSTEM	TENT SYSTEM	FOLDING SYSTEM	PULLOUT SYSTEM
CRITERIA	WEIGHTAGE					
Price	0,194444444	2	8	7	7	1
Power	0,062903226	10	8	8	9	7
Space given	0,209677419	3	8	9	10	7
Easy to use	0,155555556	5	7	6	7	8
Maintenance	0,062903226	6	9	9	8	6
Weight	0,146774194	6	7	7	6	6
Easy mounting	0,167741935	6	9	9	9	6
Relevant information						
Average		5,428571429	8	7,857142857	8	5,857142857
Normalized weighted average		0,468924731	0,792831541	0,778799283	0,800645161	0,561146953

Price	10
Power	7
Space given	10
Easy mounting	8
Maintenance	3
Weight	7

SLIDING SYSTEM

- Price: the drawer system, in order to support the weight of the box, will need so many elements, fact that increases significantly the price. In the case of the rails and the guide system, the high price of them it's due to the precision of the kind of system, but they are cheaper than the first one. The wheels and the folding tables systems are the cheapest ones because the elements that composed those systems are really simple and hence cheaper.
- Easy mounting: as the drawer system and the guide system need a more precise positioning and also previous assemblies at the factory, their grades are the lowest ones. The rails system is at an intermediate position and the wheels and folding tables system are the simplest ones.
- Adaptable to the terrain: all of the systems have a great adaptability to the terrain. The biggest grade is for the guide system because it doesn't need any support at the outside and the lowest one for the wheels system because if the ground is so irregular it's the most difficult way to take the box out of the van.
- Life: all of the systems will have a similar life, the lowest grade is for the most technical system due to they can suffer more damage with dust and oxidation.
- Maintenance: in this case, the worst system is the guide one due to, if a part changing is needed, that cost could be significantly high. The wheel system is the best one because it hasn't had so many parts, so it wouldn't require so many changes.
- Easy to use: all the systems are quite simple to use. The most difficult is the folding system as you need to mount all the parts before extracting the box. The simplest ones are the drawer and the guide system that don't need any additional support or item to extract them.
- Power: as the guide system is supposed to have an activator, the user wouldn't need to apply any force to move it. The wheels system would require the highest force to move it through the irregular soil. The rest of the systems require a similar force to move them without a motor.
- Safety in adverse conditions: as the drawer system requires several guides in each of the lateral part to support the box, if the wind is so high, it wouldn't be as resistant as the rest of the systems. The safest systems are the rails one and the folding tables, due to they have fixed supports.
- Weight: it's similar for all the systems. The heaviest one is the guide system and then the folding tables system, due to it has several elements.

EXPANDABLE SYSTEM

- Price: the most expensive systems are the adaptable and the pullout, because they require guides and other technical elements. The accordion is the cheapest as is the one that requires least metal parts and fabric. The other two have similar prices.
- Power: the power needed is minimal in all the systems. The highest one is for the pullout system, because it has to be extracted with the furniture install and it has to be move all by one.
- Space given: The highest space is given by the folding system that gives the higher height at the folded places. The lowest space is given by the adaptable system that doesn't increase its dimensions too much. The rest of them give similar dimensions.
- Easy to use: The most difficult system to use is the adaptable system as it would need to move all the walls in a specific order. The other systems are quite simple to use, while the simplest one is the pullout as you only need to take out the part from the box.
- Maintenance: the lowest grades are for the systems with more technical parts and, on the other hand, the simplest ones (accordion and tent systems) have the highest grades as they don't have so many parts and those part are not quite expensive.
- Weight: the accordion and tent system are the lightest ones due to they are mainly made by fabric (the extendable part) and then the main box by sandwich panels, while the rest of the systems are all made by this panels that, its weight, it's higher than the fabric.
- Easy mounting: the most complex assembly will be for the adaptable system and the pullout system, while the other systems are quite simple; as the first ones need several technical components to be assembled and the others are made with simple elements.

It's possible to see in tables 3 and 4 that the systems with the highest normalized weighted average are *the folding tables system* (chapter 4.2.5) for the sliding system and *the folding system* (chapter 4.3.4) for the expandable system, so this are the ones selected to develop the product.

4.5 POWER

After evaluating the design alternatives and selecting the best option for each of the subsystems, the possibility of automate them has to be evaluated.

The sliding system selected is the *folding tables system* and it doesn't require too much force to extract the box from the van as it has four wheels and one only need to slide them over the floor and the folding tables. So, in this case, we decide that it has no sense to automate it due to the fact that it will increase the price of the system and this automation it’s not really necessary to use the system.

In the case of the expandable system, we’ve selected the _**folding system**_, where you unfold several layers of walls to construct another two rooms at both sides of the box. To perform this automation, a complex electrical system and many actuators would be needed, because when the layers are folded inside the box, no actuator can be put between them and to unfold every wall you would need to move them to different directions, so, we also decide not to automate this system.

5 SYSTEM DESIGN

The final design of the system is presented in this chapter.

It's composed by the main box (see main dimensions in chapter 4.1) at which the expandable and the sliding system are attached. The sliding system is also connected to the van, allowing the box to move outside of it.

Dimensions of components forming the expandable part of movable box are limited by external dimensions of the main box (Fig. 10.).

The applied solution presented in Fig. 38. allows to obtain additional usable space on volume of about 7 cubic meters and additional floor of 6 square meters.

Fig. 38. shows the whole assembly of the system with its main subassemblies.

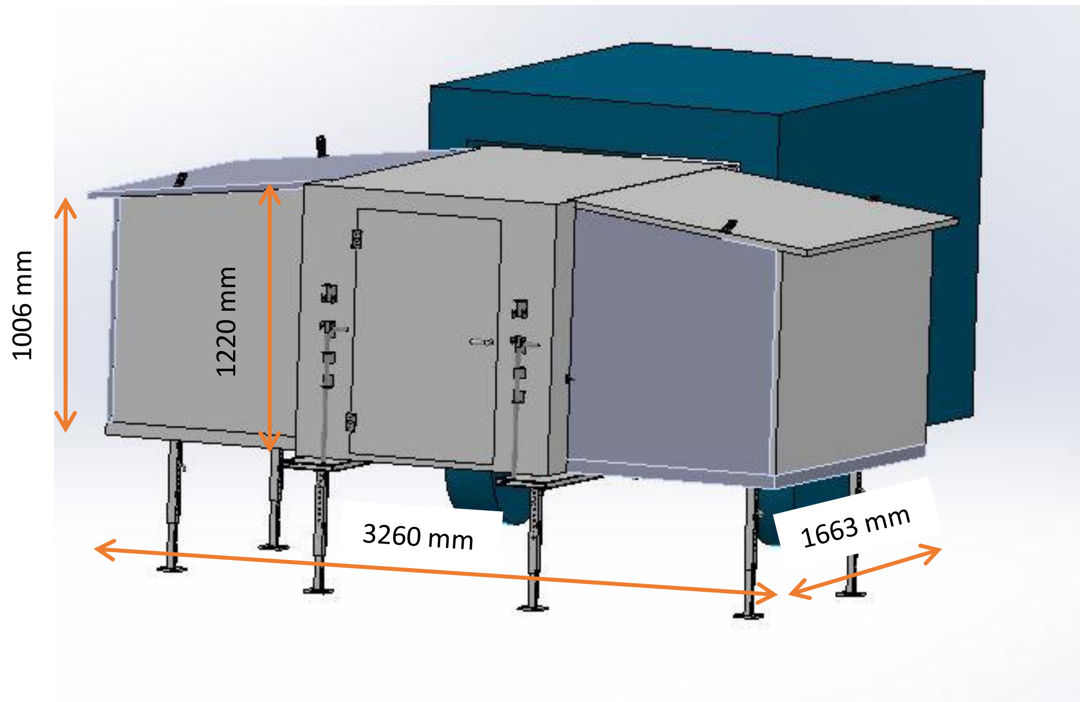


Fig. 38 a. General presentation of the system

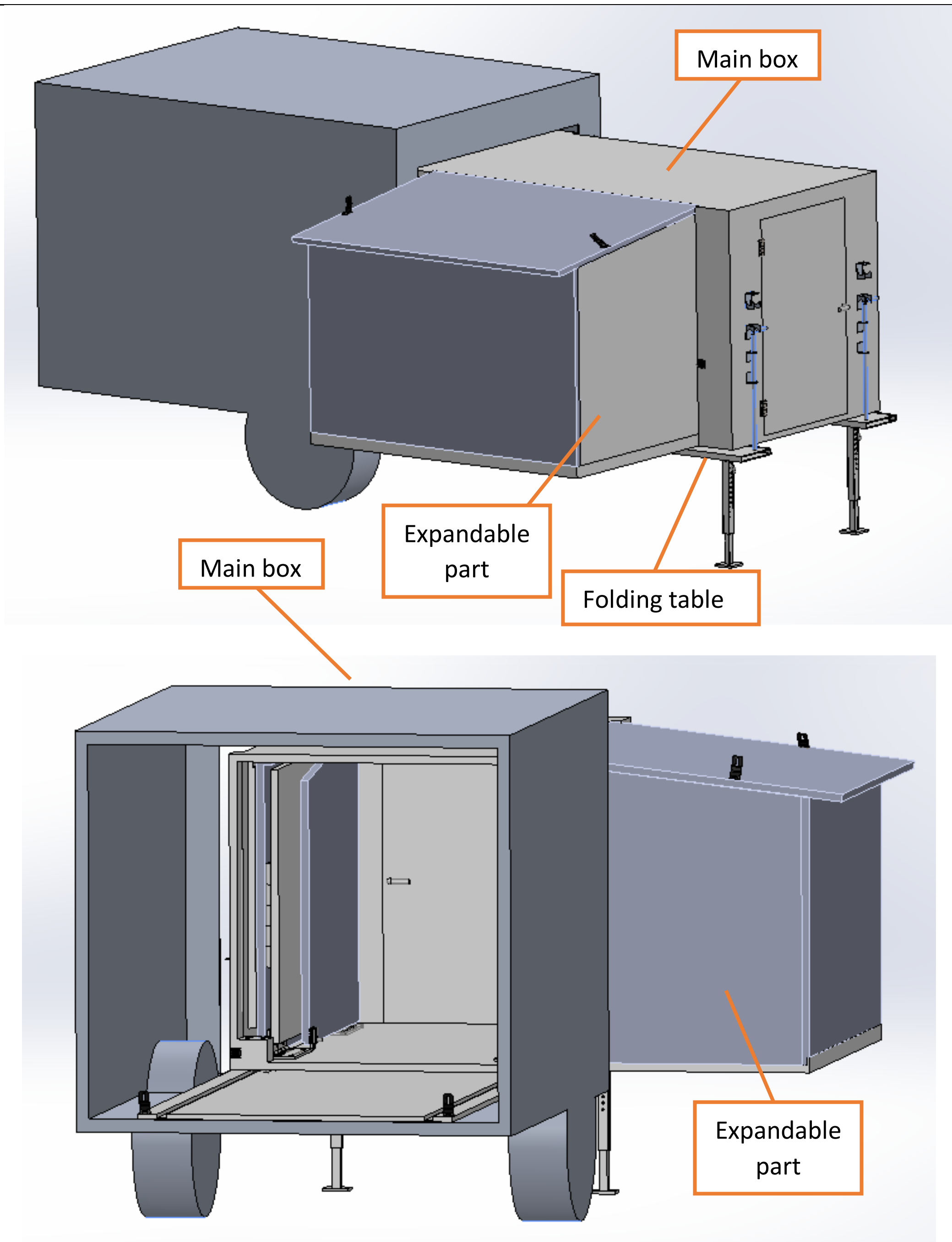


Fig. 38 b. General presentation of the system

All the components of each system are shown in the following chapters, as well as the calculus performed during design procedure.

The technical drawings are attached to the Annex. A preliminary view is shown in chapter 5.4.

5.1 BOX

The main box (see Fig. 39.), at which the expandable and sliding system has been attached, is the principal component of the final system. It's been made of sandwich panels (composite, see Fig. 30 b.), in order to insulate the van.

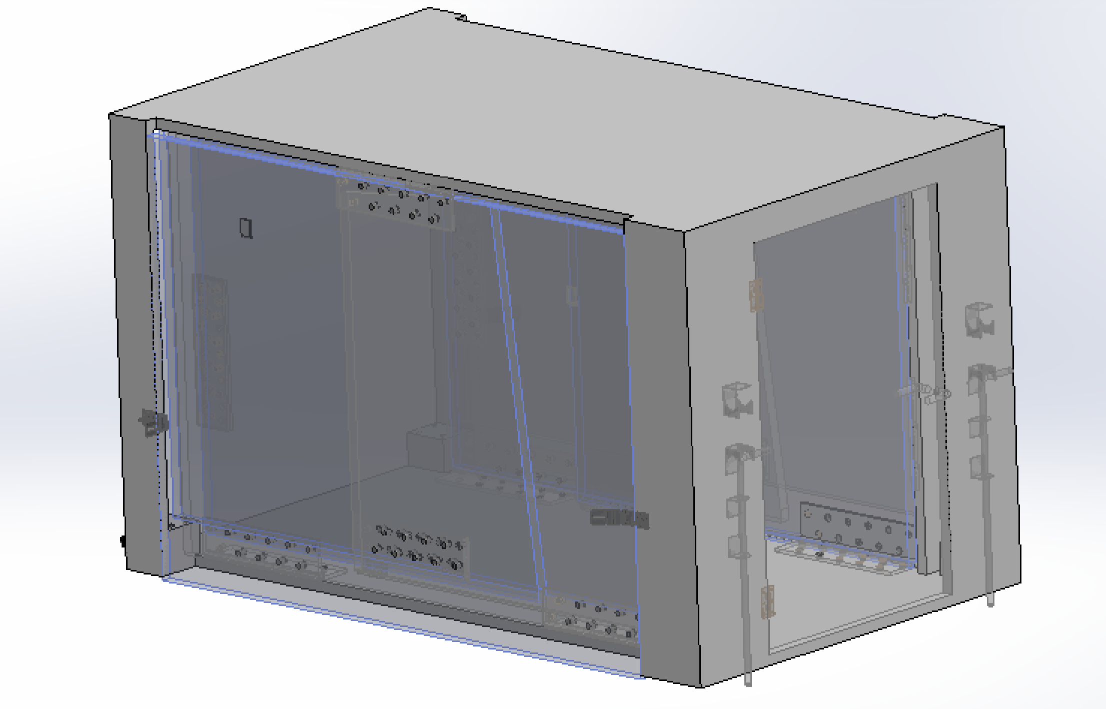


Fig. 39. Main box

At the front part we have a door in order to go inside the box, and the back part is open to connect the box with the van while it's at the outside. The lateral parts have holes in its walls to connect the expandable system to them (see Fig. 40.).

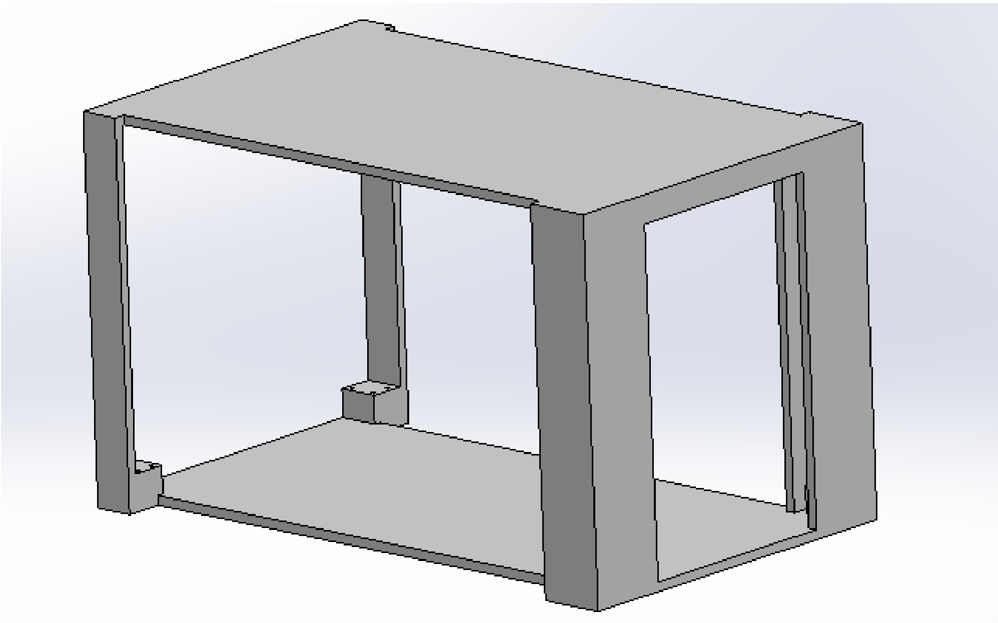


Fig. 40. Chassis of the main box

The main problem of the box is to isolate the van from the outside in the models that have a great clearance with respect to the box. The solution for this problem is adding some fabric, attached to the box and with some magnets at the other side of the fabric, hold it to the roof and walls of the inside part of the van (see Fig. 41.).

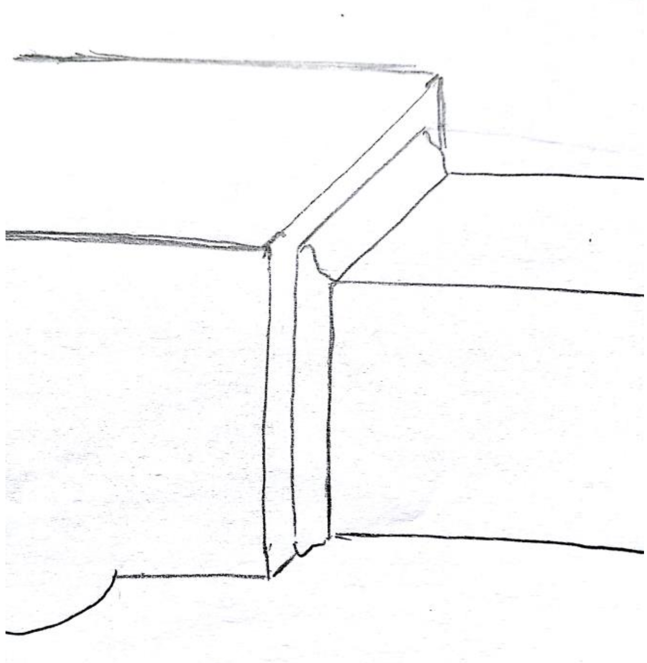


Fig. 41. Sketch isolation solution

The box is manufactured by IPM-Mondia, it is a company which manufacture sandwich panels (see Fig. 42.) made to measure and also chassis. It solves the problem of manufacturing the box, a drawing with measures is the only thing necessary to send to them. It also would perform and attached the door to the main box.

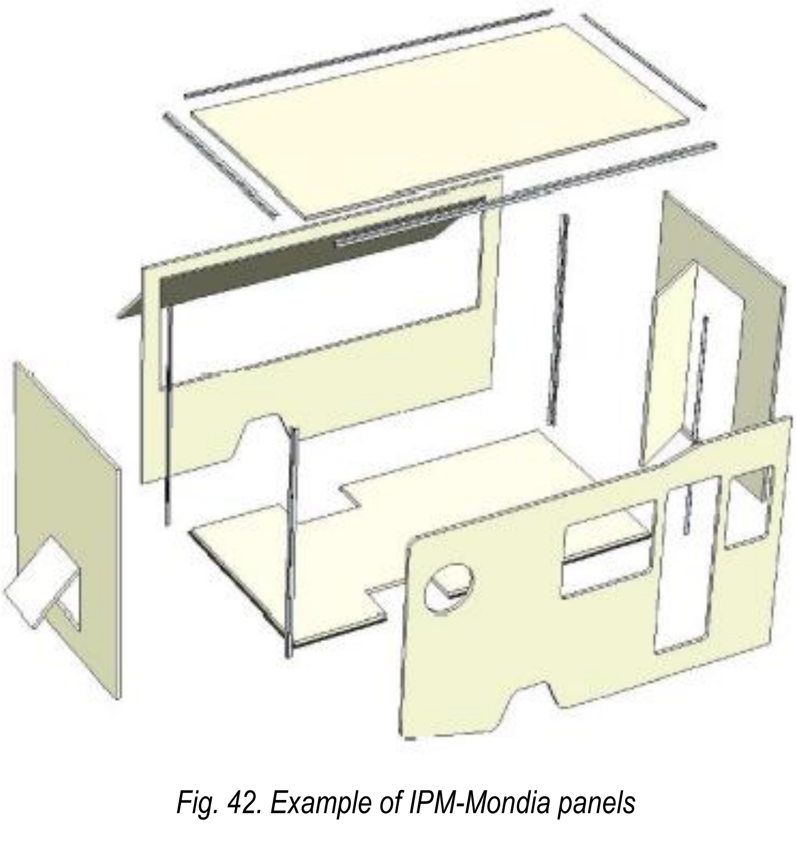


Fig. 42. Example of IPM-Mondia panels

This company also has a good solution for panels used for walls, some of them have a rabbet, as it is shown in Fig. 43.,it is made of wood.

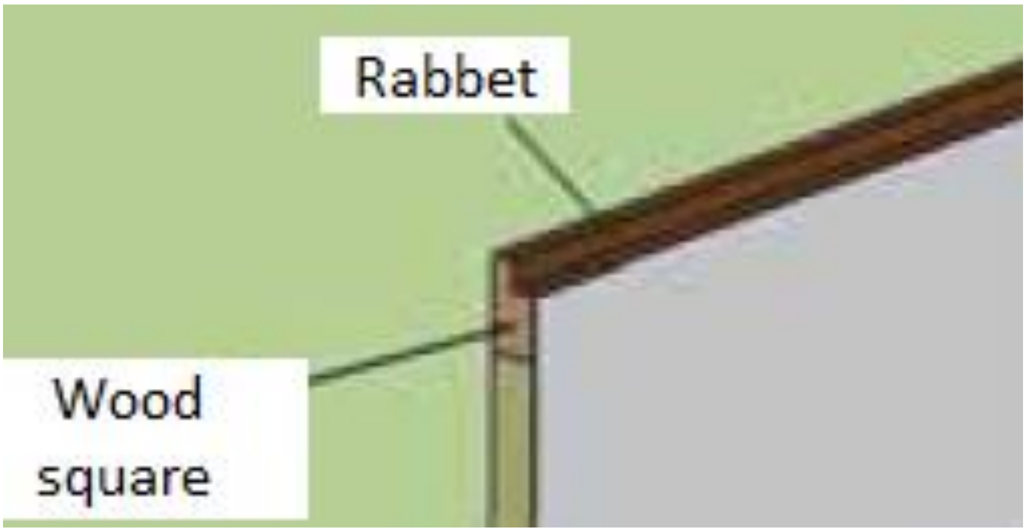


Fig. 43. Squares of panels

The box is composed by the following parts:

- Chassis: is the main component. Its main dimensions and shape are shown in Fig. 60. and Fig. 61.
- Door: it's also made by composite. It's fixed to the van with some hinges.
- Aluminum plates: they're used to cover the holes for the wheels and to fix them to the box. They're welded to the chassis (see Fig. 65.).

A preview of the technical drawings is shown below. Technical drawings in their original format can be found in Annex.

5.2 SLIDING SYSTEM

This system (Fig. 44.) allows the user to move the box from the van to the outside and the other way round.

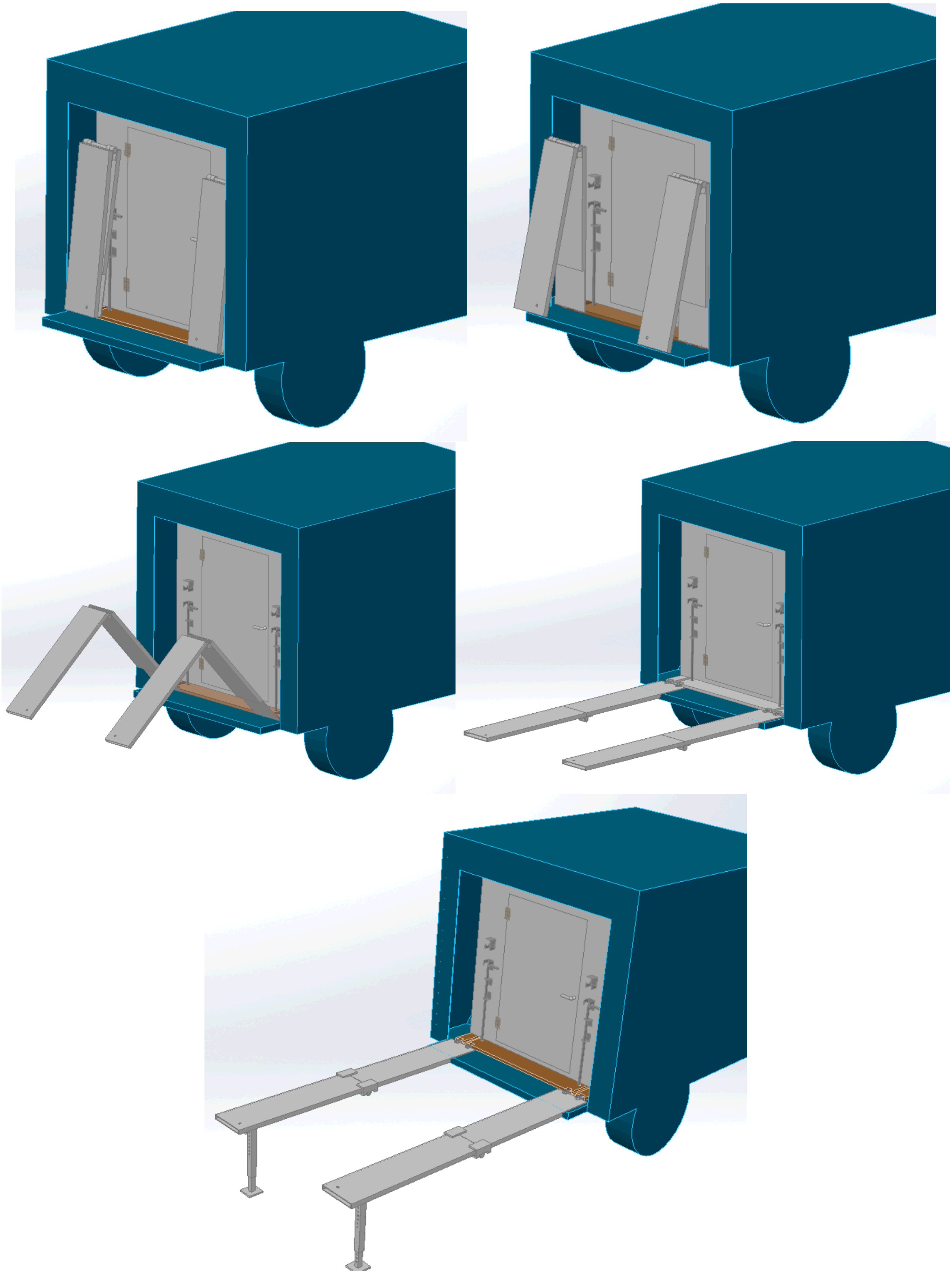


Fig.44a. Folding tables

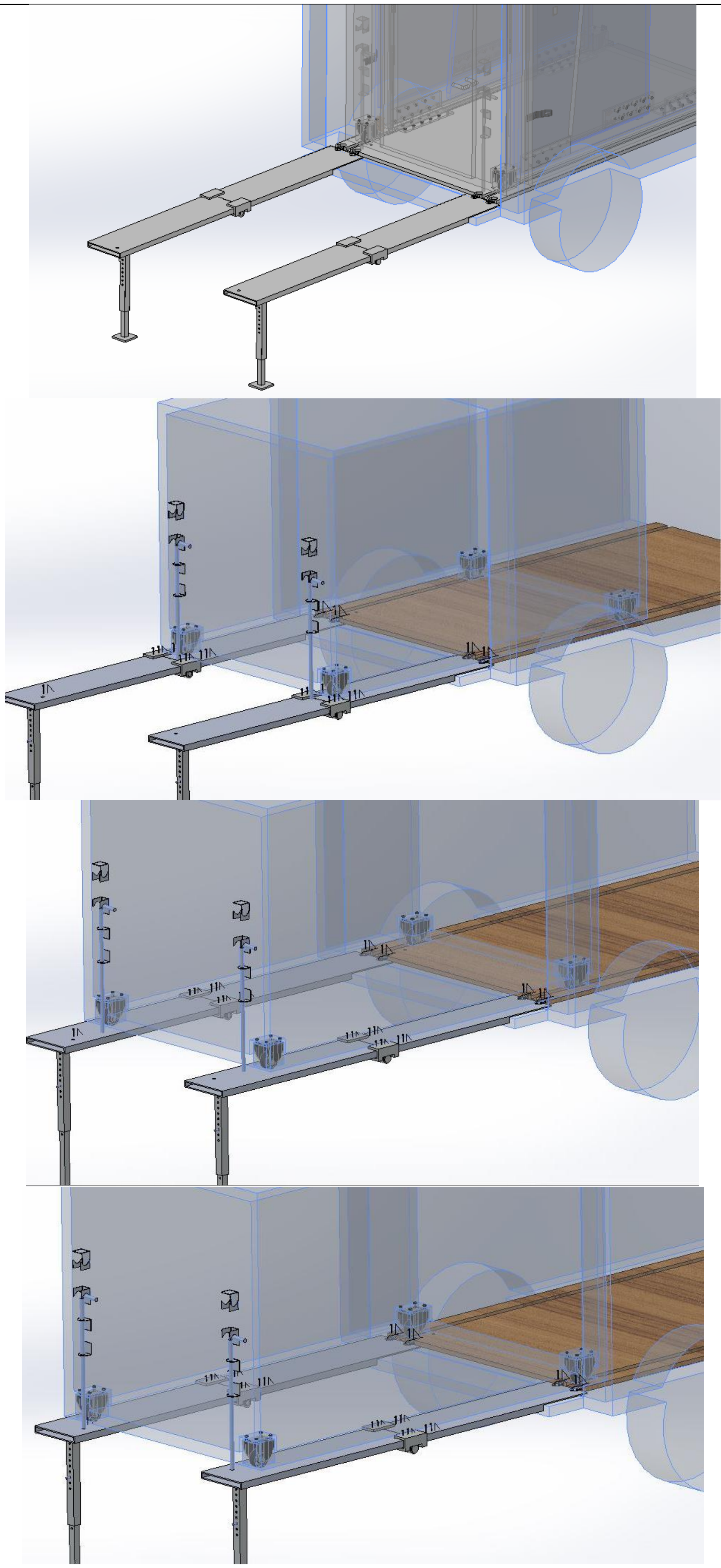


Fig. 44b. Movable box on the folding table

It's composed by a wood floor (Fig. 76.) attached to the van with two parallel guides for facilitating the movement of the 4 wheels (Fig. 25 a.) of the box. In order to extract the box from the van, four folding tables (Fig. 28.) are joined to the floor by mean of some hinges and fixed to the ground with two fixed support. As the vans have a ledge outside the back doors, these folding tables should have some modifications due to the fact that, if not, the wheels should overtake a 30 mm high table that would require a huge force.

When the folding table is introduce in the van after introducing the box in it, the fixed supports are separate from the tables and they are folded one over the other and kept on the back part of the van.

The stiffness of the system at the division between the tables was increased by means of a huge hinge (Fig. 70. and Fig. 72.) and two additional pieces (Fig. 75.).

Another way of performing this system would be with U profiles instead of rectangular tubes to avoiding the cutting of the frontal part of the tables but, if so, the stiffness wouldn't have been increased with such part, as it needs a square/rectangular shape to be positioning, and probably it wouldn't support the load or has a great displacement.

5.3 EXPANDABLE SYSTEM

This system allows the user to obtain more space when the box is outside the van. It's attached to the main box by means of some hinges (shown in Fig. 45.) and to the ground by some fixed support attached to the floor (Fig. 16 b.).

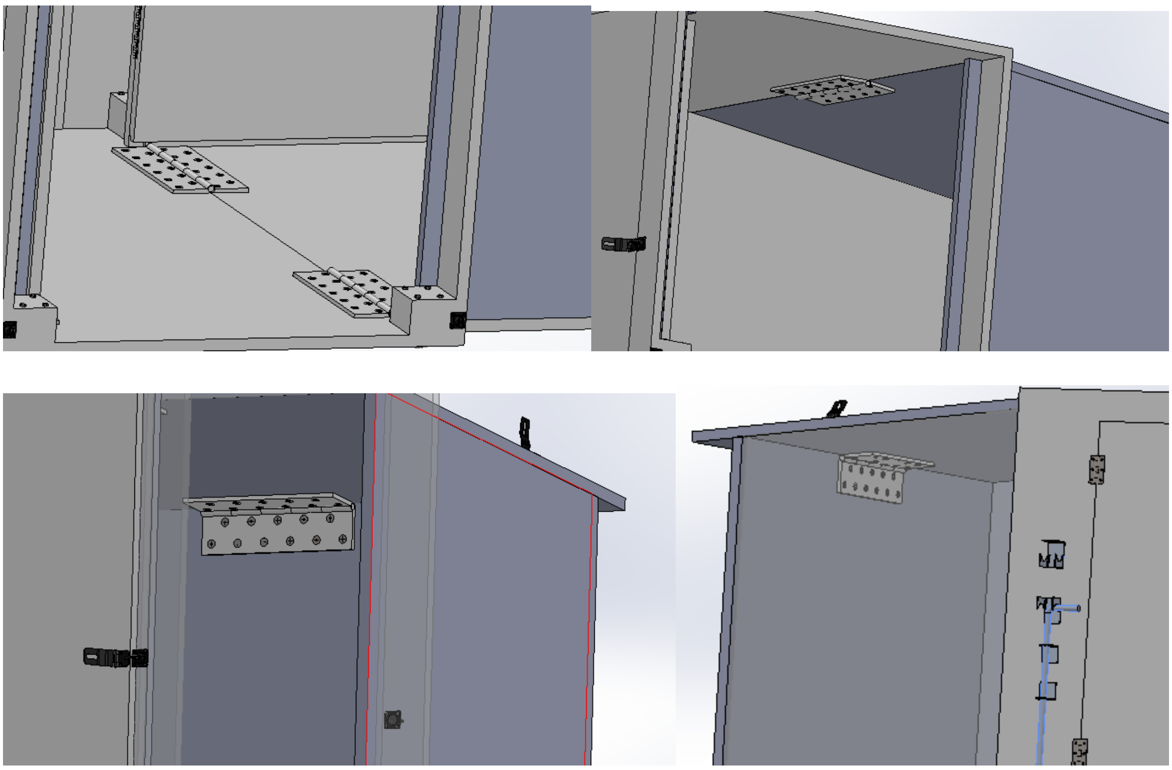


Fig. 45. Assembly of expandable system

The mechanism is simple; some walls are joined to the box and, by unfolding them at each of the lateral parts of the box, it's obtained two more "rooms" (see Fig. 46.).

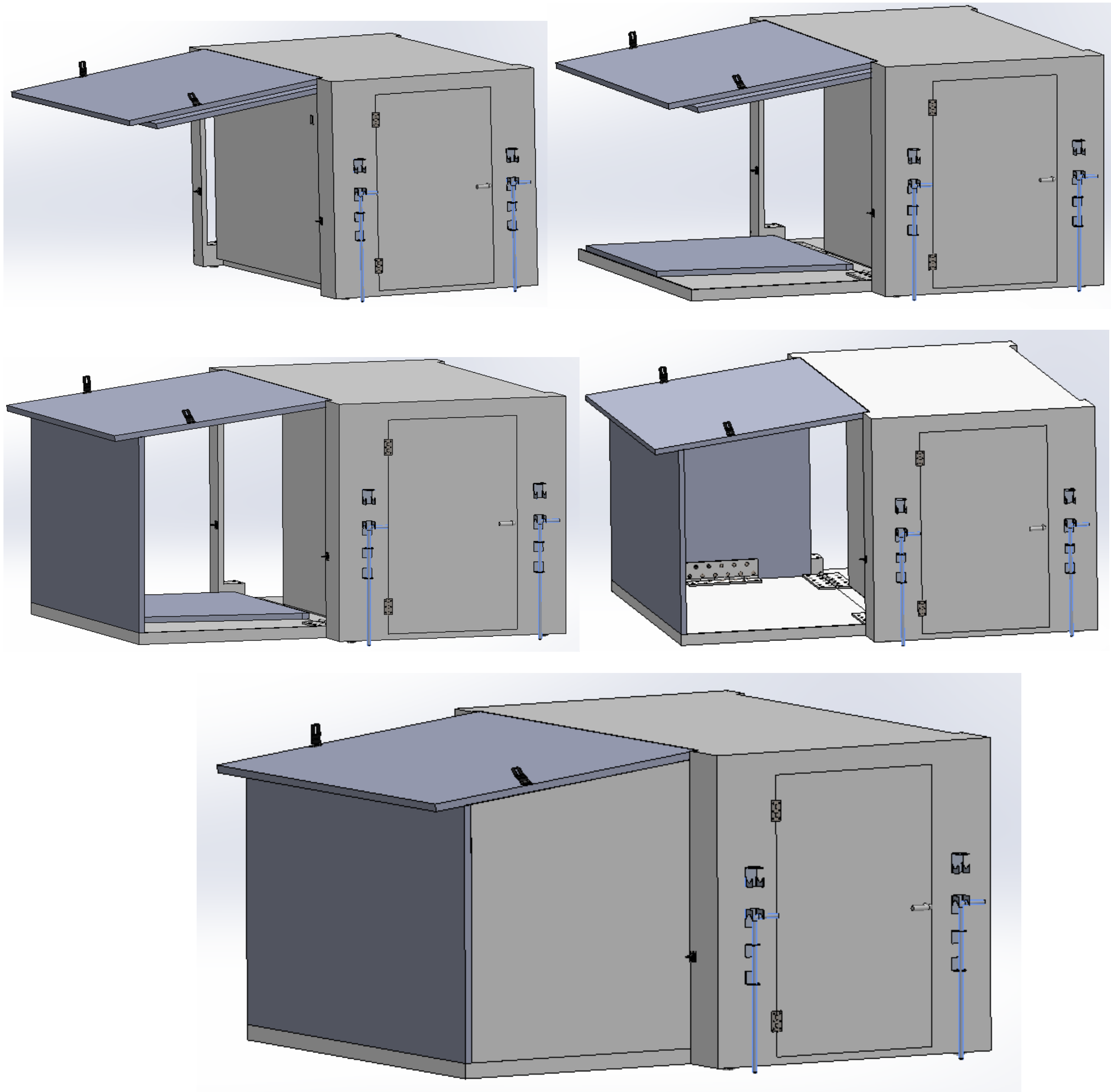


Fig. 46. Stages of unfolding the expandable system

Before introducing the box inside the van, this system must be unfolded and fixed to the box with some latches attached at the inside and outside of the box (see Fig. 47.).

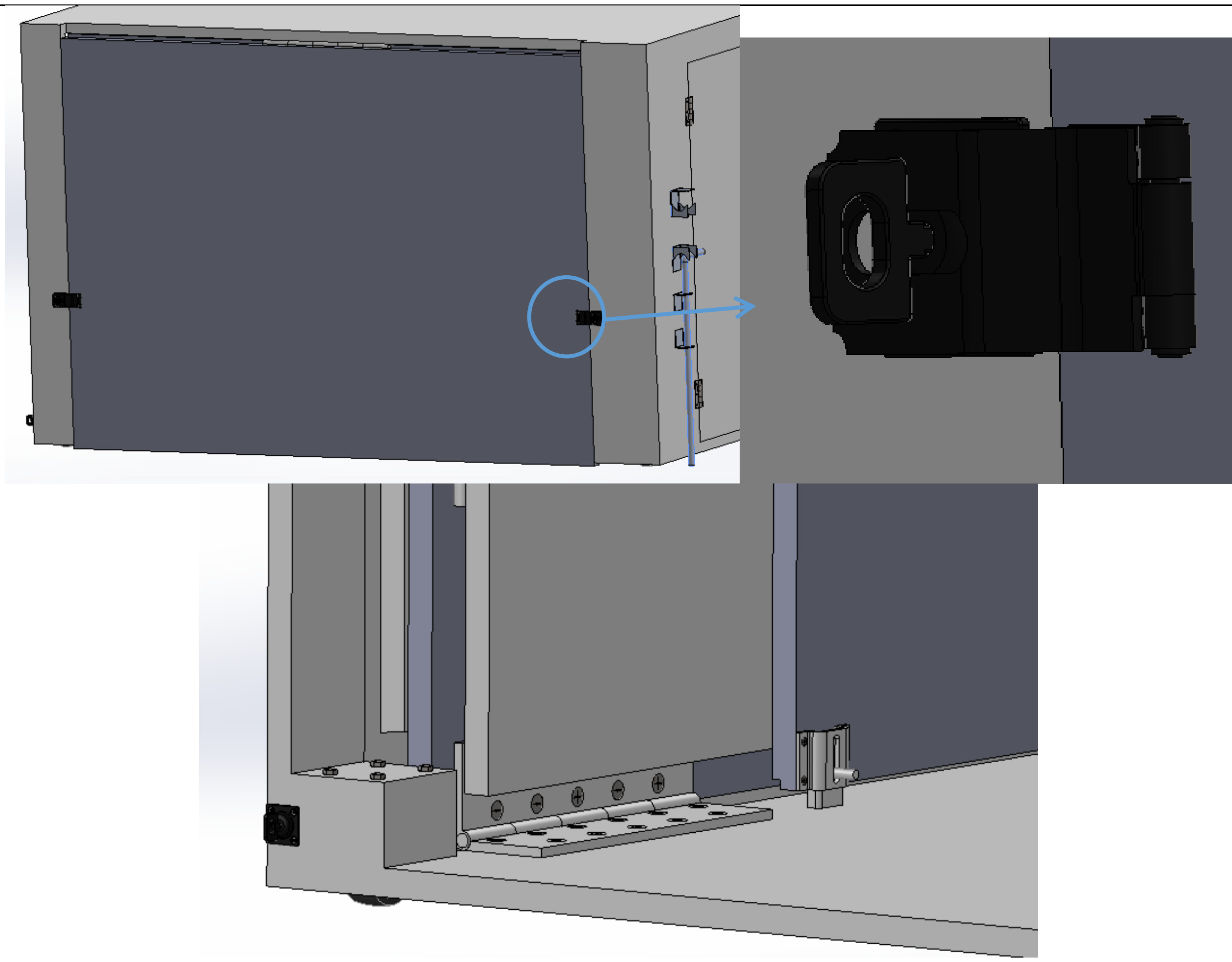


Fig. 47. Fixing of expandable system

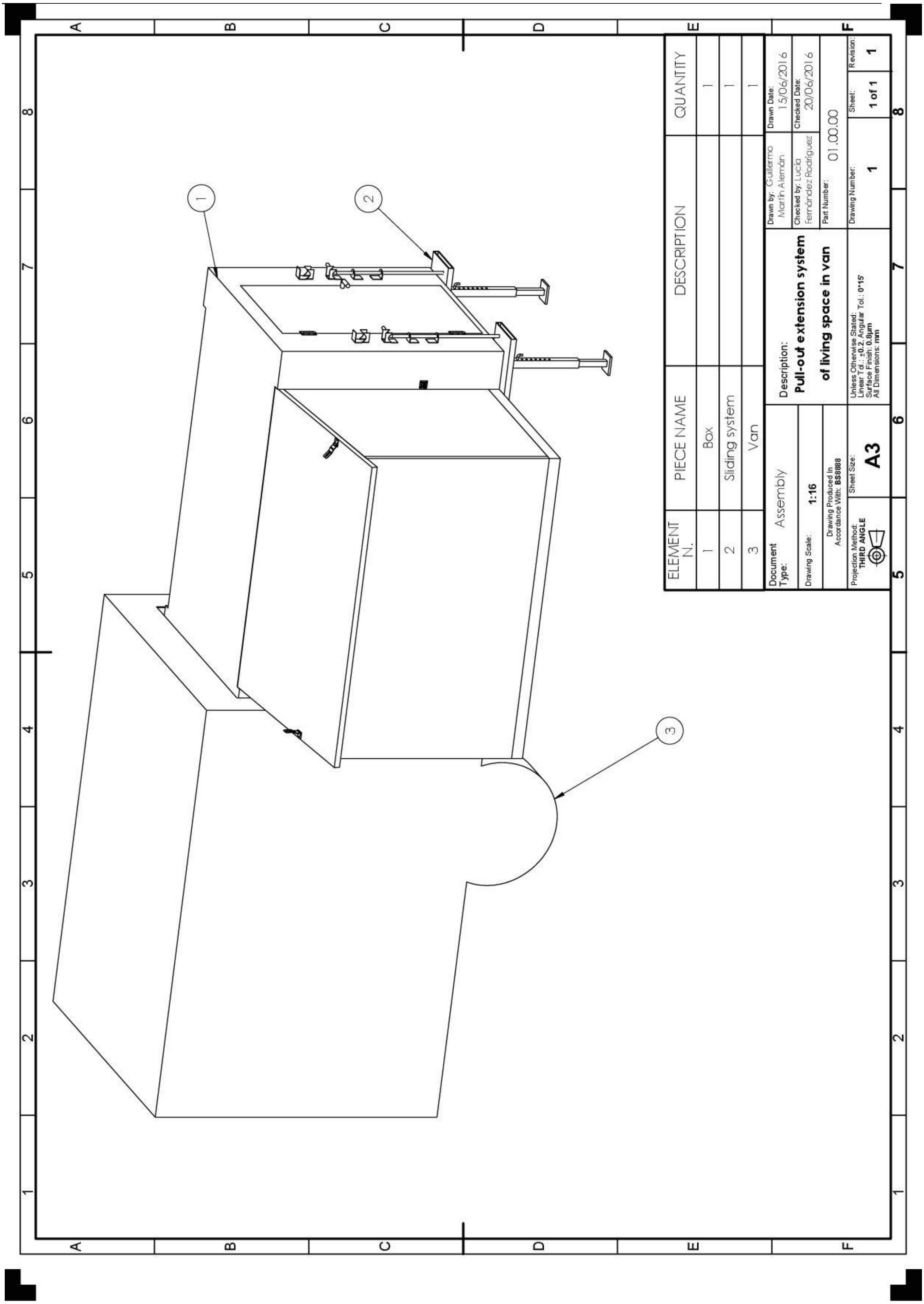
The walls are also made of composite (Fig. 30 b.). The first idea was to machine the walls, floors and roofs in order to fixed the hinges on it so they doesn't bother for walking inside the box but, as they are made of composite, it's easier and more secure to fixed those hinges to the aluminium cover of the composite than to the inner part.

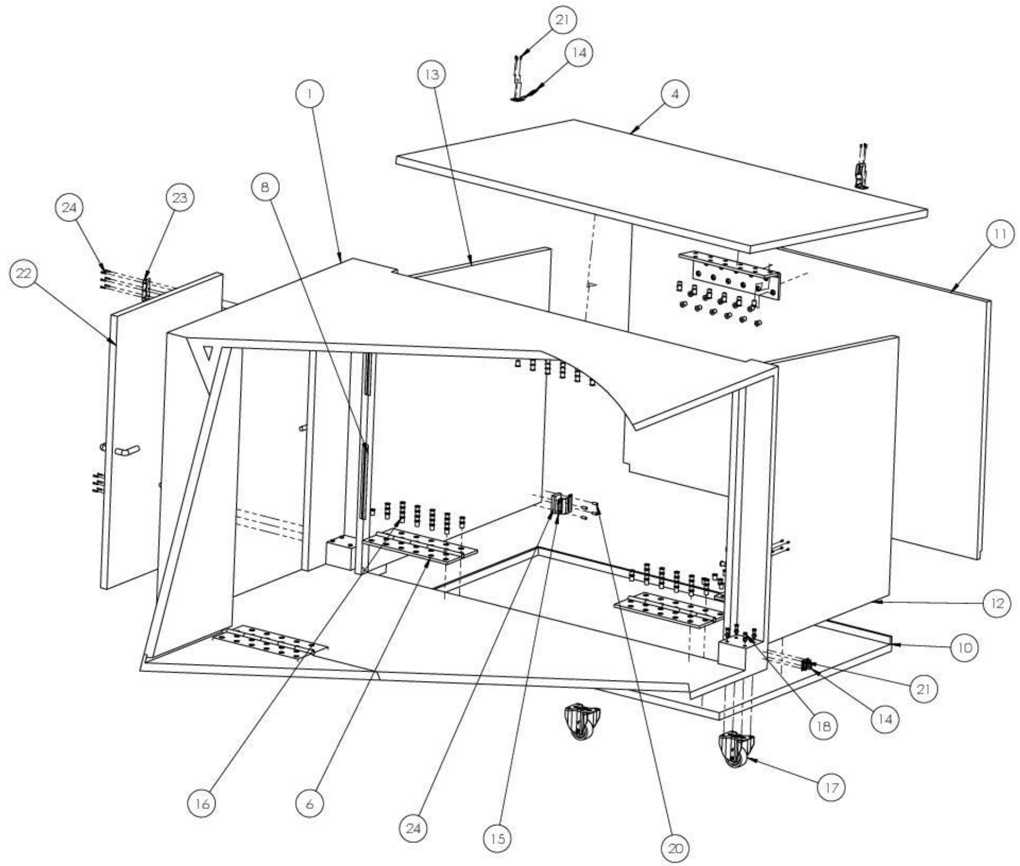
5.4 ASSEMBLY DRAWINGS

Detailed presentation of the system designed one can find in the assembly drawings presented below:

- Pull-out extension system
- Expandable box (2 drawings)
- Sliding system

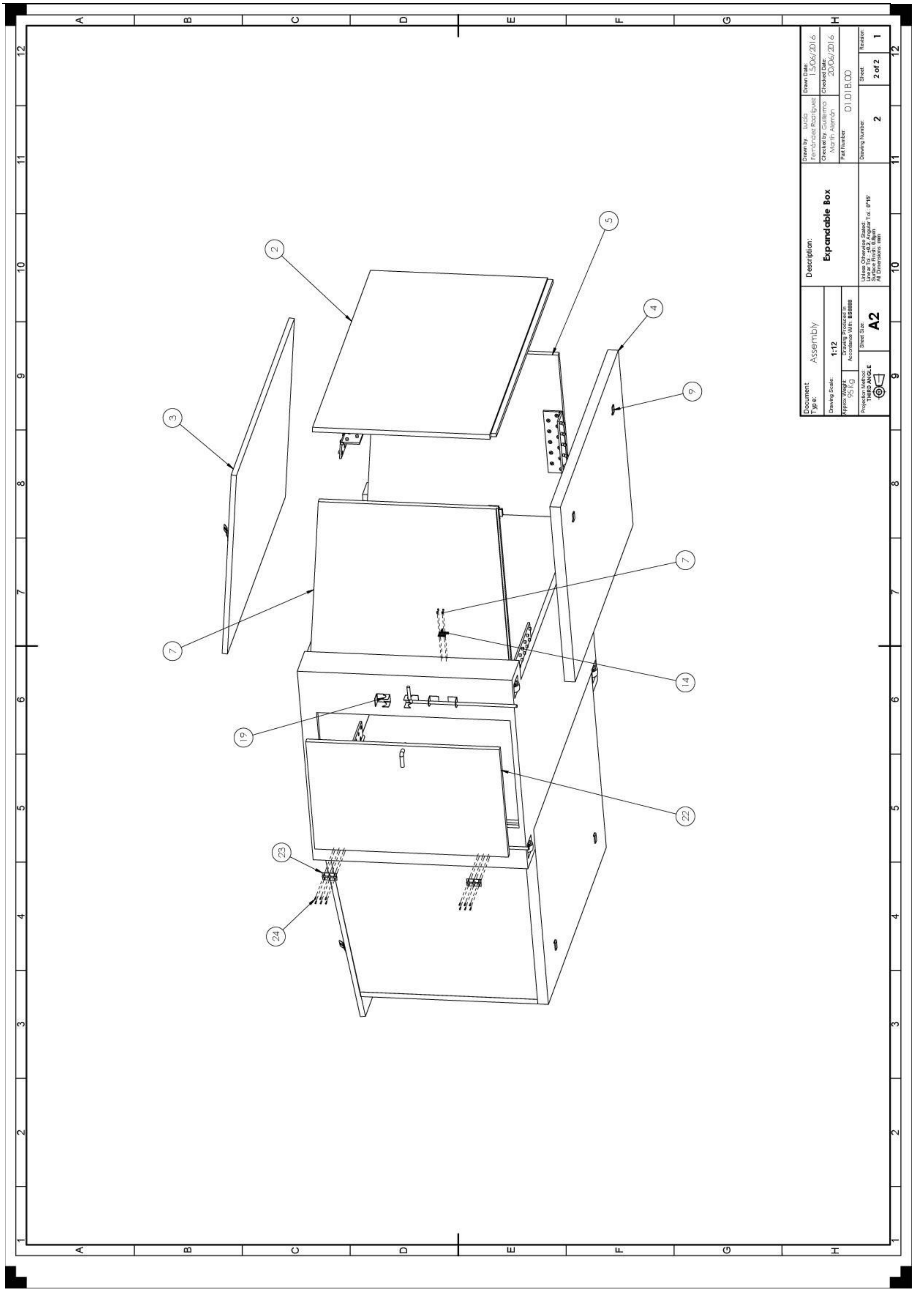
The working drawings of selected system elements are presented in the Annex. Names of elements are related to names assigned in assembly drawings.


1
2
3
ELEMENT N.
PIECE NAME
DESCRIPTION
QUANTITY
1
Box
1
2
Sliding system
1
3
Van
1
Document Type:
Assembly
Description:
Pull-out extension system of living space in van
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Drawing Scale: 1:16
Drawing Produced In Accordance With: BS8888
Part Number: 01.00.00
Projection Method: THIRD ANGLE
Sheet Size: A3
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8μm All Dimensions: mm
Drawing Number: 1
Sheet: 1 of 1
Revision: 1



ELEMENT N.	PIECE NAME	DESCRIPTION	QUANTITY
1	Box	Composite panel	1
2	Frontwall expandable system(right)	Composite panel	1
3	Roof expandable system	Composite panel	2
4	Floor expandable system (right)	Composite panel	1
5	Side wall 1 expandable system (right)	Composite panel	1
6	Hinge walls		10
7	Side wall 2 expandable system (right)	Composite panel	1
8	Hinge side walls		4
9	Subjection	Aluminum 7075-T7351	4
10	Floor expandable system (left)	Composite panel	1
11	Frontwall expandable system(left)	Composite panel	1
12	Side wall 1 expandable system (left)	Composite panel	1
13	Side wall 2 expandable system (left)	Composite panel	1
14	Latch roof		6
15	Latch floor		2
16	Screw M15		221
17	Wheel	Resin	4
18	Nut bolt		16
19	Dead bolt		2
20	Screw M8		8
21	Screw M5		36
22	Door	Composite panel	1
23	Hinge door		2
24	Screw M4.5		12

Document Type: Assembly		Description: Expandable Box	Drawn by: Lucía Fernández Rodríguez	Drawn Date: 15/06/2016
Drawing Scale: 1:12			Checked by: Guillermo Martín Alemán	Checked Date: 20/06/2016
Approx Weight: 95 Kg	Drawing Produced in Accordance With: BS8888		Part Number: 01.01A.00	
Projection Method: THIRD ANGLE	Sheet Size: A2	Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8μm All Dimensions: mm	Drawing Number: 1	Sheet: 1 of 2 Revision: 1


Document Type: Assembly
Drawing Scale: 1:12
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Drawn by: Lucía Fernández Rodríguez
Drawn Date: 15/06/2016
Checked by: Guillermo Martín Alemán
Checked Date: 20/06/2016
Part Number: 01.01B.00
Drawing Number: 2
Sheet: 2 of 2
Revision: 1
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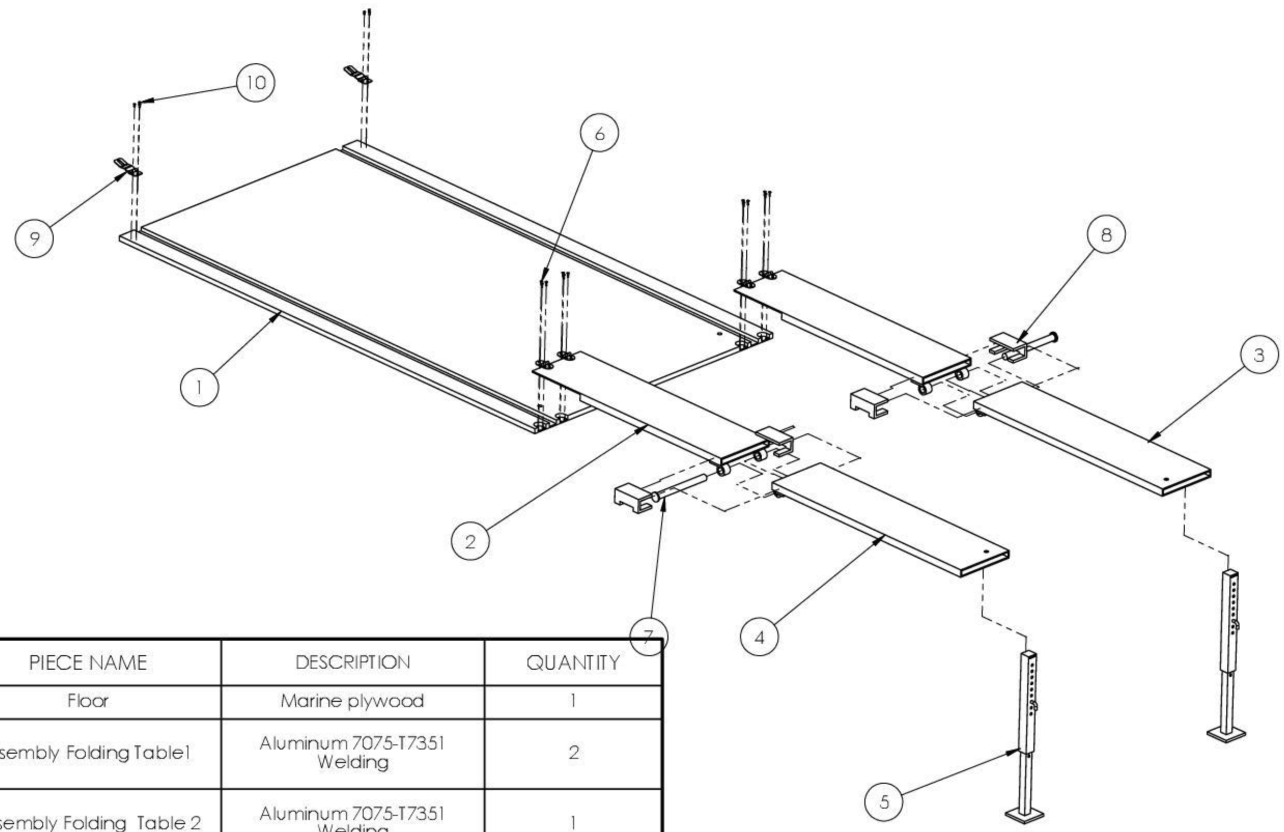

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2	Assembly Folding Table1	Aluminum 7075-T7351 Welding	2
3	Assembly Folding Table 2	Aluminum 7075-T7351 Welding	1
4	Assembly Folding Table 3	Aluminum 7075-T7351 Welding	1
5	Support		2
6	Screw M5		12
7	Pin	Aluminum 7075-T7351	2
8	Subjection	Aluminum 7075-T7351	4
9	Latch		2
10	Screw M5		6

Document Type: Assembly		Description: Sliding system	Drawn by: Guillermo Martín Alemán	Drawn Date: 15/06/2016
Drawing Scale: 1:16			Checked by: Lucía Fernández Rodríguez	Checked Date: 20/06/2016
Approx Weight: 77 Kg	Drawing Produced In Accordance With: BS8888		Part Number: 01.02.00	
Projection Method: THIRD ANGLE	Sheet Size: A3	Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm	Drawing Number: 1	Sheet: 1 of 1 Revision: 1

5.5 CALCULATIONS

Below, some strength calculations related to selected system elements are presented. All calculations have been performed with SolidWorks using a safety factor of 3.

5.5.1 BOX

The floor of the box is made of composite, with 4 holes for the wheels that are closed with some aluminum plates welded to the box. Some calculations are made in order to know if it will support 1 ton of mass. The results are shown below.

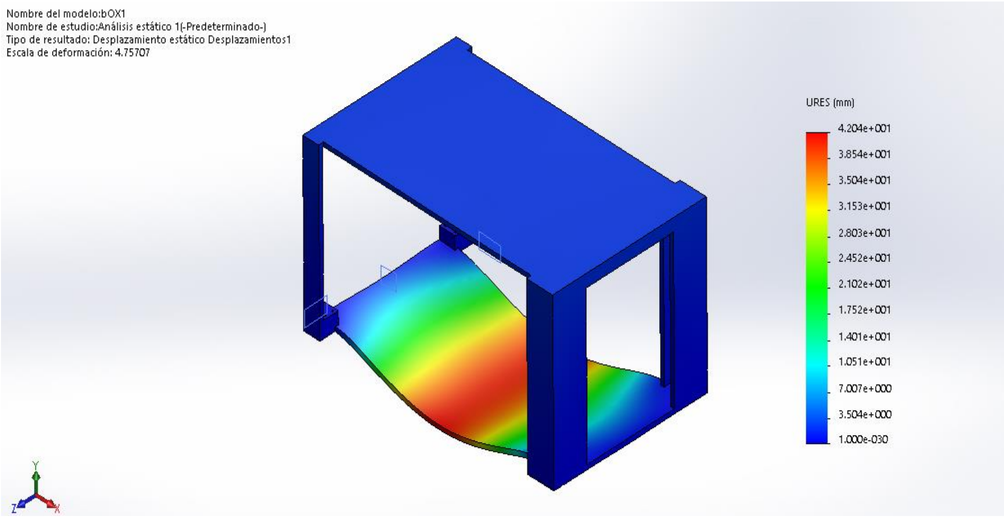

Fig. 48. Displacements results

In Fig. 48. it's possible to see that the displacement at the center part of the box will be 4 cm if a mass of 1 ton is place on it that is not a bad result taking into account the lightweight and width of the box floor.

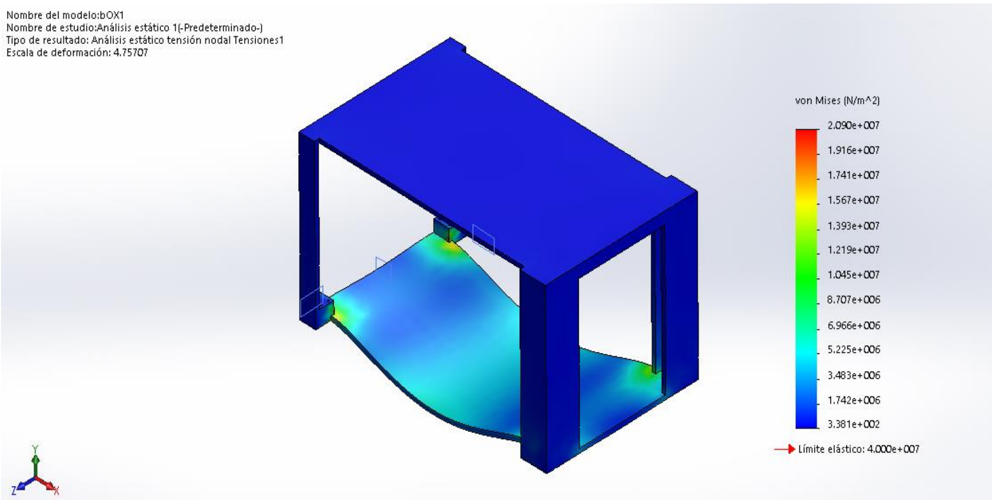

Fig. 49. Stresses results

On the other hand, in Fig. 49., by means of a graphical scale, the stress support by the box is shown. It can be deduced that the parts that suffer more stress are the wheel boxes (21 MPa). As the yield strength for the aluminum is 435 MPa and for the composite panels is around 40 MPa, it will support the mass without breaking.

5.5.2 SLIDING SYSTEM

In this system, two calculations have been performed in order to know if the folding tables will support 1 ton of mass while the box is been extracted. In Fig. 50. it is possible to see that the mesh is more refined near the critical points.

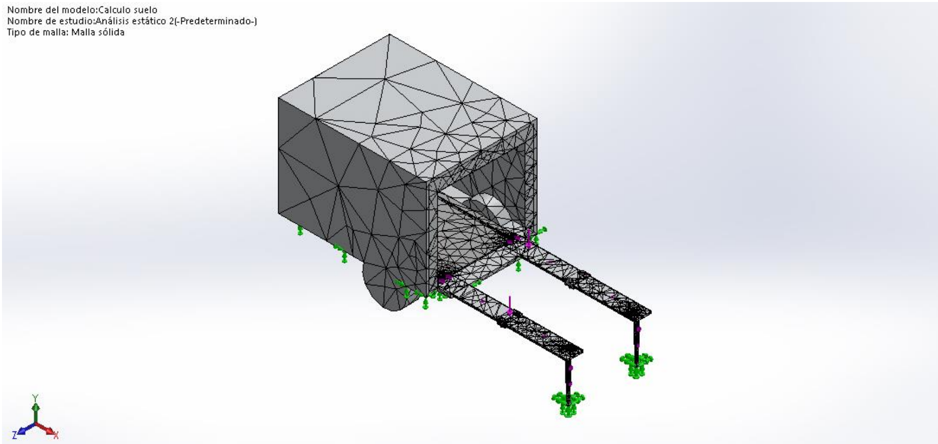

Fig. 50. Mesh

The two critical positions (Fig. 51.) are evaluated below.

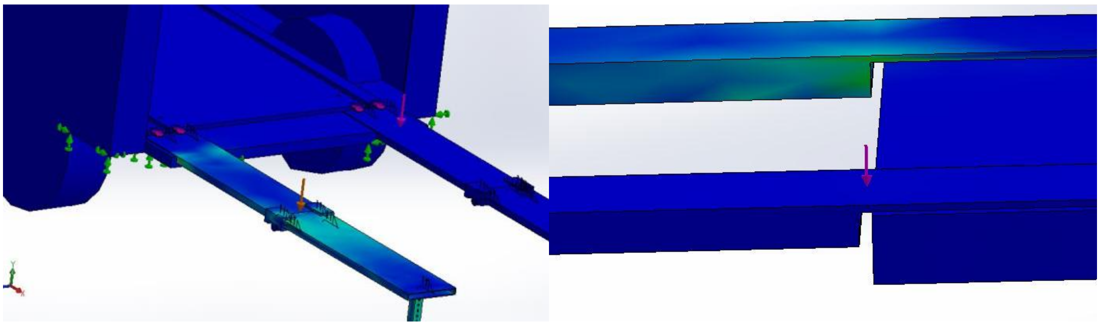

Fig. 51. Critical points

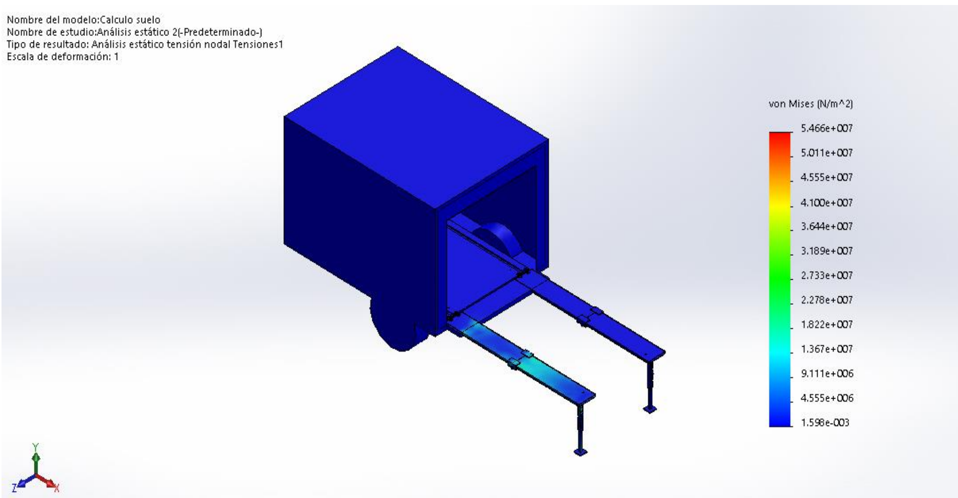

Fig. 52. Stresses results

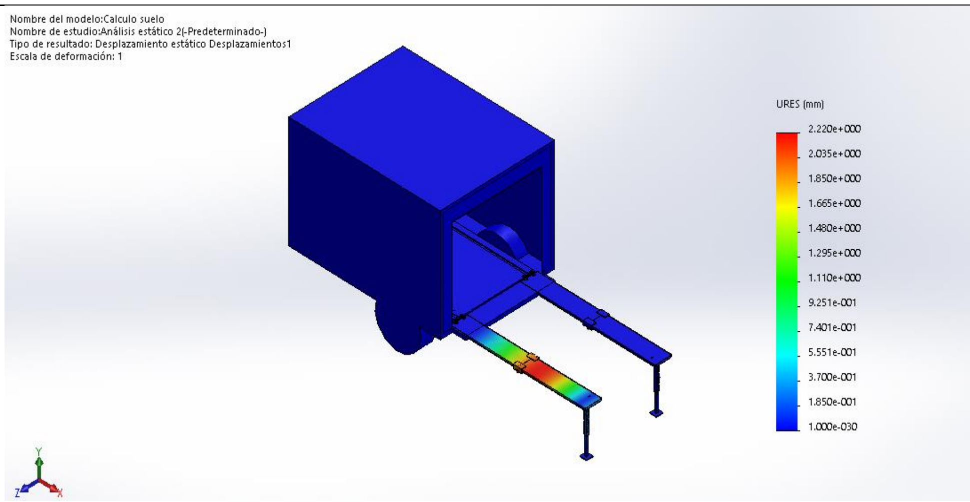

Fig. 53. Displacements results

In the first case, the wheel is at the first point that leaves the subjection of the van.

On the other case, the wheels are between both tables.

In both cases the folding tables support the weight because the maximum stress is 54 MPa (Fig. 52.) and the yield strength of the aluminum is 435 MPa. And the maximum displacement is approximately 2 mm (Fig. 53.).

5.6 ASSEMBLY TO THE VAN

The only part attached to the van is the floor by means of some bolts at the corners and the center of the wood table. There's no need of preliminary holes or marks, the user just need to directly screw the bolts somewhere near the specified positions.

5.7 FURNITURE AND ADDITIONAL COMPONENTS[13]

To improve the comfort inside the van and the box, some ideas of folding furniture to include on them have been developed.

BED

While the box is inside the van, at both sides of it there is empty space (over the wheels) so, in order to take advantage of all this space, two beds (one in each side of the van) are placed as shown in Fig. 54.

[13] The images have been taken from the websites [21],[22], [23] and [24] (Bibliography)

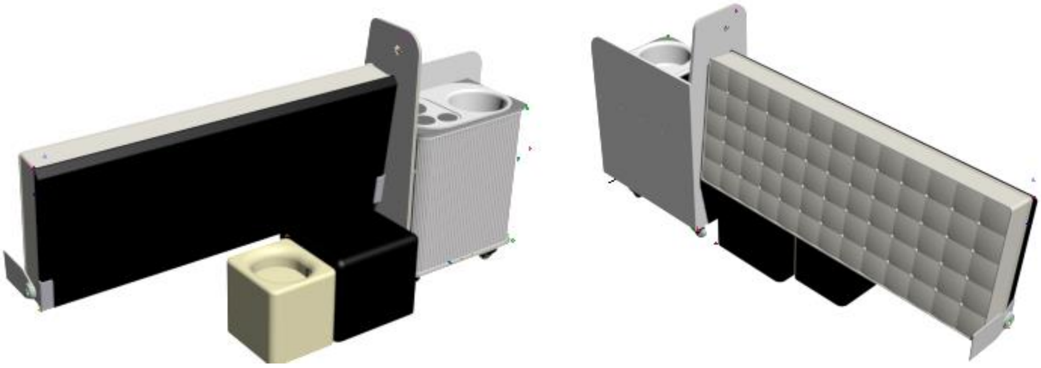

Fig. 54. Bed system

It is possible to add an extra square support (as the ones in Fig. 54.) for given more stability to the beds while open. This support could be transported inside the box

TABLE

There are two designs for tables, depending on if a big or a small table is more suitable for the user. They are shown in Fig. 55. and Fig. 56.

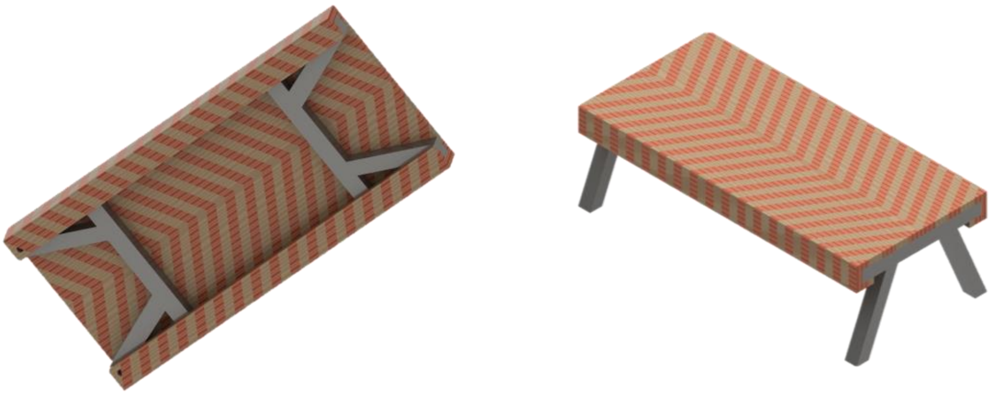

Fig. 55. Table design 1

Fig. 56. Table design 2

SEATS

Some ideas for folding seats are shown in Fig. 57. and Fig. 58.

Fig. 57. Seat design 1

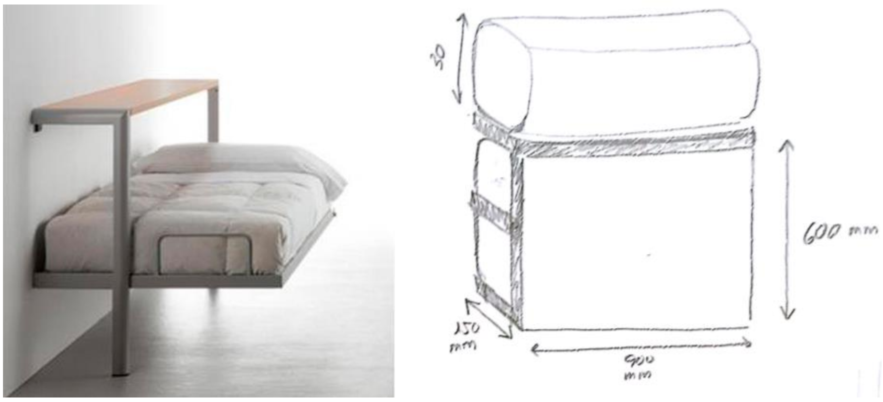

Fig. 58. Seat design 2

In the Fig. 58. an idea from a folding bed is developed, converting the external structure into a kind of box that supports itself without any fixing elements and adding a backrest by introducing a soft rectangular shape throw the upper holes while the seat is unfolded.

SINK

For a more comfortable use of water while cooking, washing or other activities, a sink with a water pump could be added to the furniture. A general idea is shown in Fig. 59.

Fig. 59. Sink idea

5.8 BUDGET

The price of the design system has been estimated as stated in table 5.

Table 5. Budget

PROJECT BUDGET

	MATERIALS	QUANTITY	PRICE (€)	TOTAL PRICE
SIDING SYSTEM	Aluminum tables	28,20 kg	2,50 €/kg	70,50 €
	Bought hinges	4	0,50 €/u	2,00 €
	Designed hinges	0,1 kg	2,50 €/kg	0,01 €
	Screws	12	0,05 €/u	0,60 €
	Pin	0,35 kg	2,50 €/kg	0,88 €
	Plywood floor	0,50 m3	200 €/m3	100,00 €
	Wheels	4	14,55 €/u	58,20 €
	Couplings	0,022 kg	2,50 €/kg	0,06 €
	Supports	2	20 €/u	40,00 €
	Subtotal			**272,24 €**

EXPANDABLE SYSTEM AND BOX	Box	1	250,00 €/u	250,00 €
	Composite panels	8	10,75 €/u	86,00 €
	Big hinges	10	2,50 €/u	25,00 €
	Small hinges	4	0,50 €/u	2,00 €
	Screws	110	0,05 €/u	5,50 €
	Supports	4	20 €/u	80,00 €
	Couplings	0,022 kg	2,50 €/kg	0,06 €
	Latches	8	1,50 €/u	12,00 €
	Textil	4 m	10,00 €/m	40,00 €
	Magnets	6	0,15 €/u	0,90 €
	Wheels boxes	8 kg	2,50 €/kg	20,00 €
	Subtotal			**521,46 €**

	PROCESSES	TOTAL PRICE
MANUFACTURING AND ASSEMBLY PROCESSES	Weldings	5,00 €
	Cutting	15,00 €
	Drilling	3,00 €
	Subtotal	**23,00 €**

		LICENSE PRICE	SPENT HOURS	LICENSE PRICE/HOUR	TOTAL PRICE (€)
SOFTWARE	SolidWorks	6.105,00 €	344,00	0,80 €	275,20 €
	Microsoft Office	6.020,00 €			50,00 €
	Subtotal				**325,20 €**

Total	**1.141,89 €**

The estimated price is 1141,89 €.

6 CONCLUSION

The system of the movable/expandable box for van-type vehicles has been designed within the framework of this project. The box can be mounted inside the cargo/passenger section of the van and it enables the vehicle to obtain significant additional usable space.

The proposed solution and its technical and economic parameters indicate that established requirements (table 1) and assumptions (chapter 3) have been met.

First of all, the system cost seems to be relatively low (about 1140€; see chapter 5.8).

The movable and expandable box enables the vehicle to get a 7-cubic-meters additional space, giving a great boost to the tourism industry.

It is very important to point out that the suggested system is not intended for just a car model. It can be installed in a number of currently manufactured vans (chapter 4.1).

The manufactured of the proposed system is very simple. The assembly in the van (after a preassembly of the welded parts at the factory is performed) wouldn't cause any problem for the user.

Easy use and maintenance of the system result from its simplicity.

Some sketches and ideas of folding furniture which could be added to the system are shown in chapter 5.6.

This system has also fulfilled some desires described in chapter 3.2, which are the light weight of the elements (whole system 172kg) and the use of insulated materials for the walls of the box, which provides a high standard of comfort.

However it must be considered as a prototype. It can be improved in many aspects: adding some windows to the walls, developing the ideas of the folding furniture, improving the design and the access to the box from the outside. Also the box could get waterproof. Finally, an electrical system to have electricity could be installed to improve the user´s experience and a level to ease the positioning of the sliding system outside, as well as automating the sliding system to facilitate its pull-out.

7 REFERENCES

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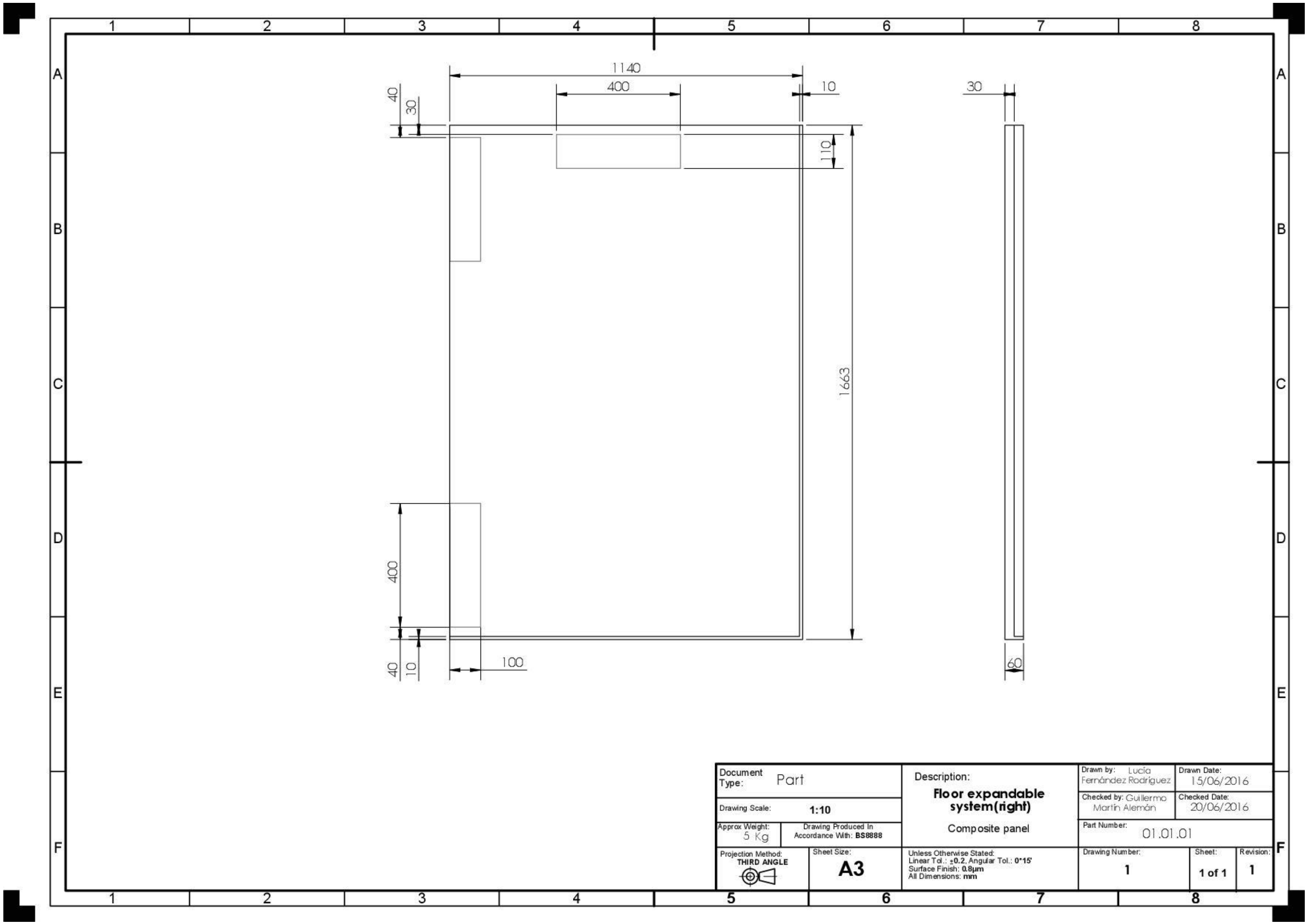
ANNEX

Working drawings of selected system elements.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Checked Date: 20/06/2016
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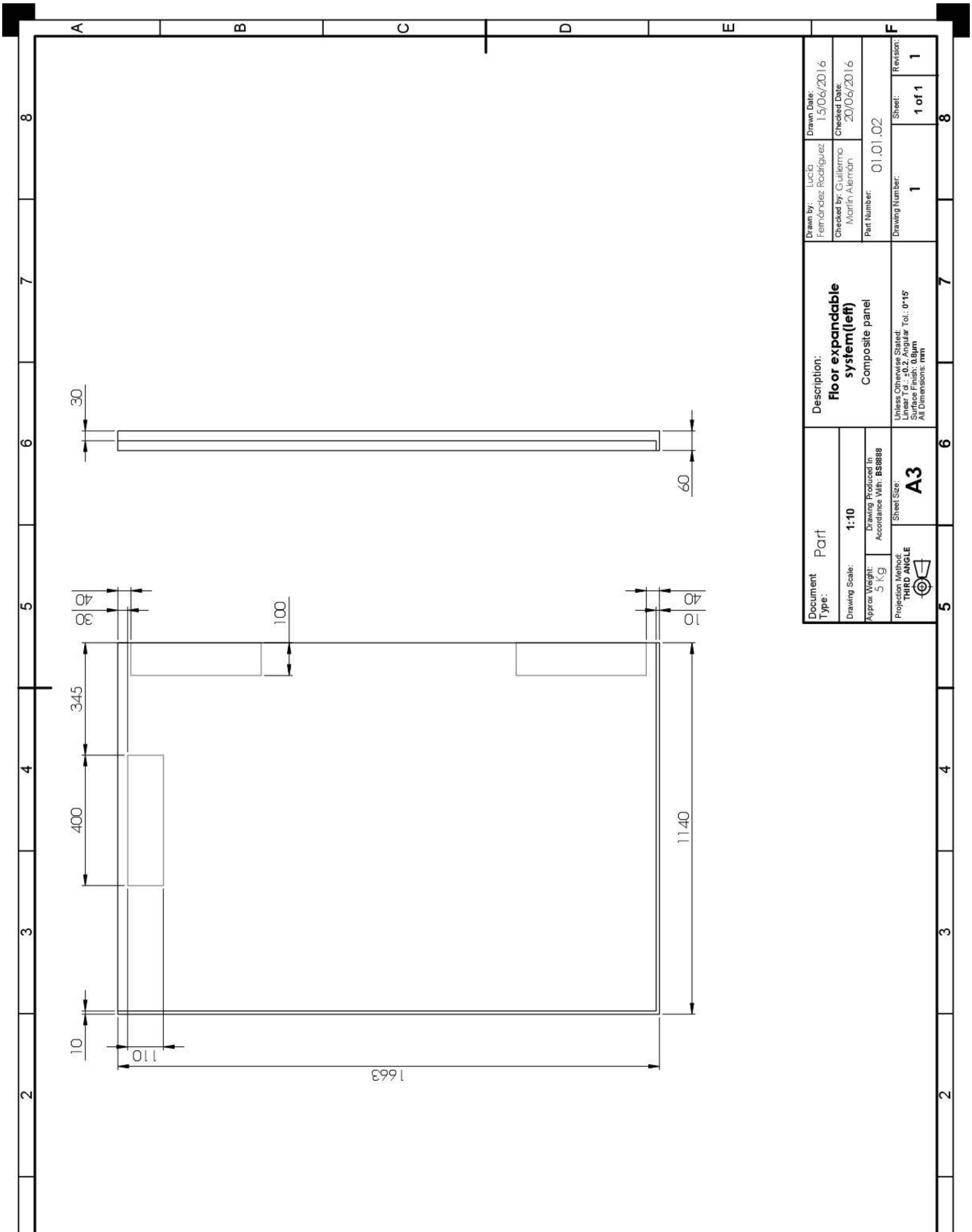
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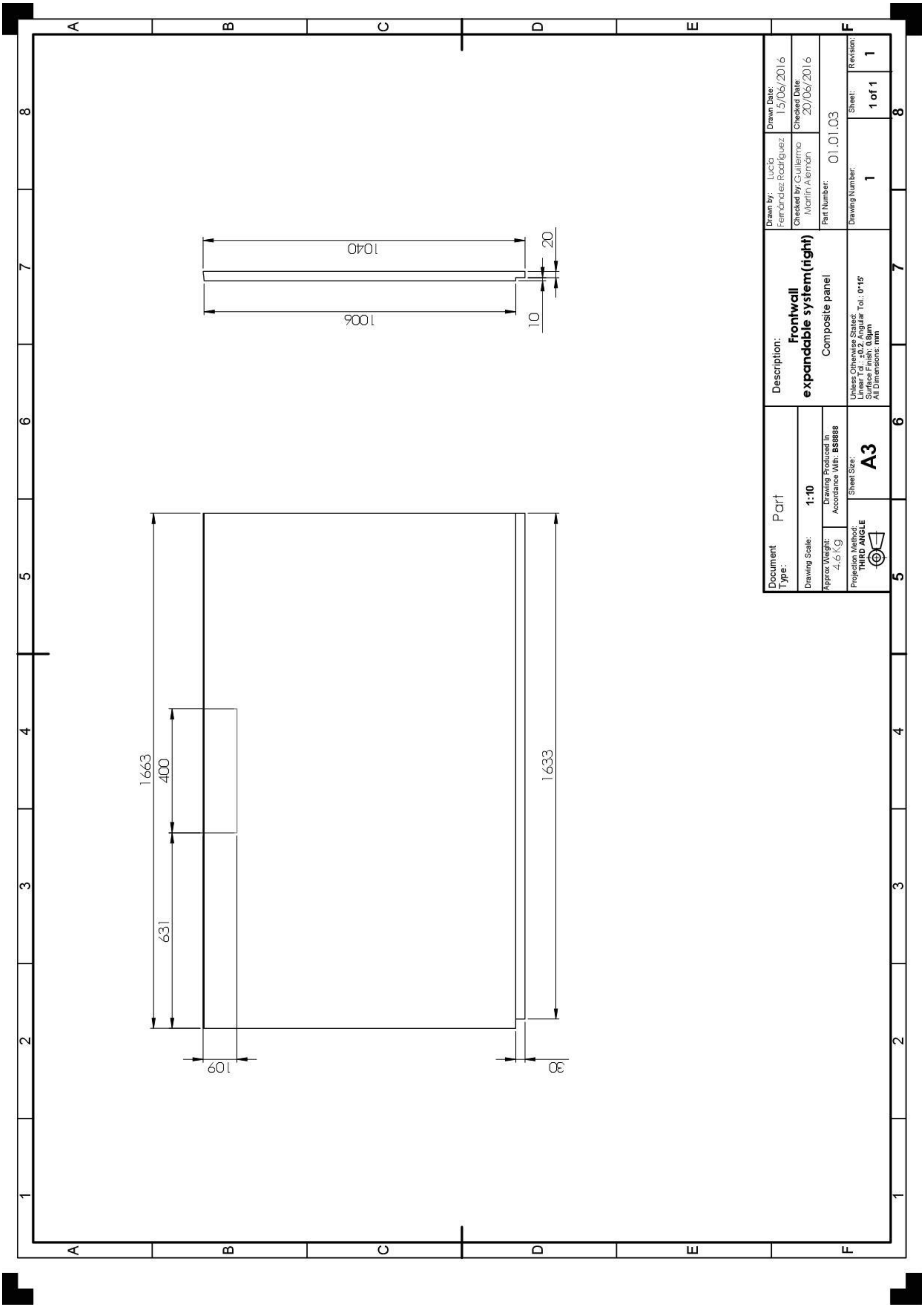
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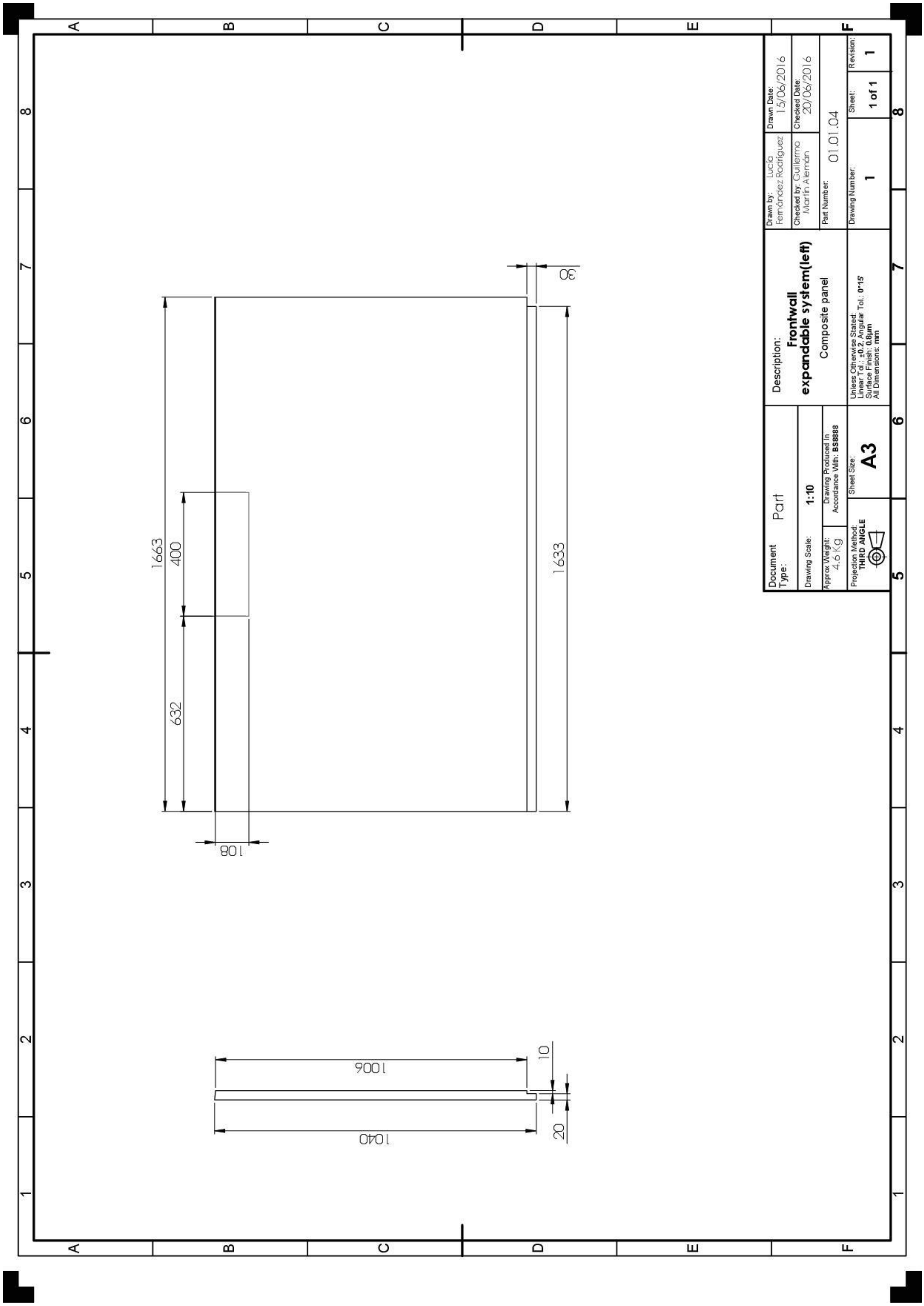
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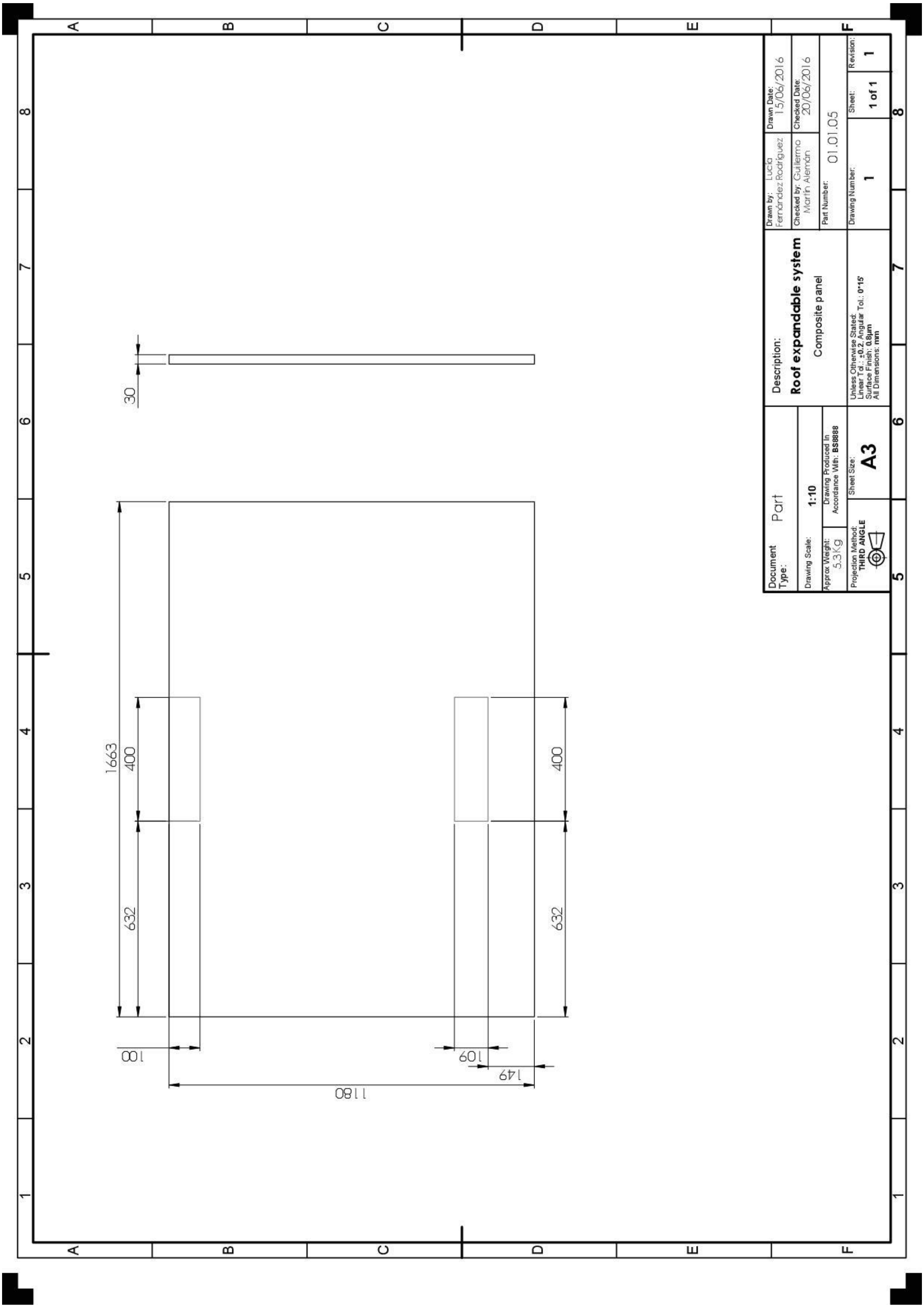

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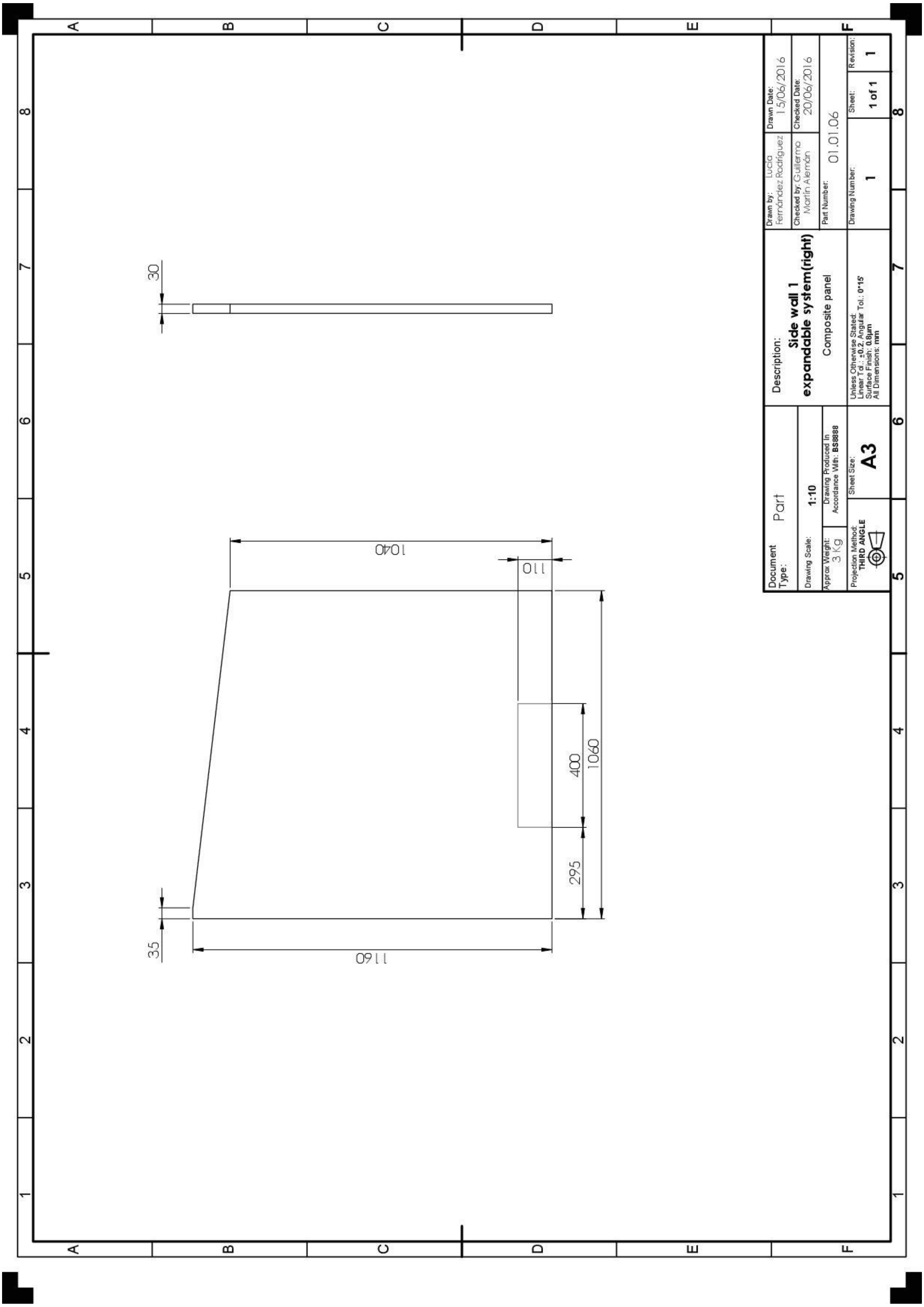
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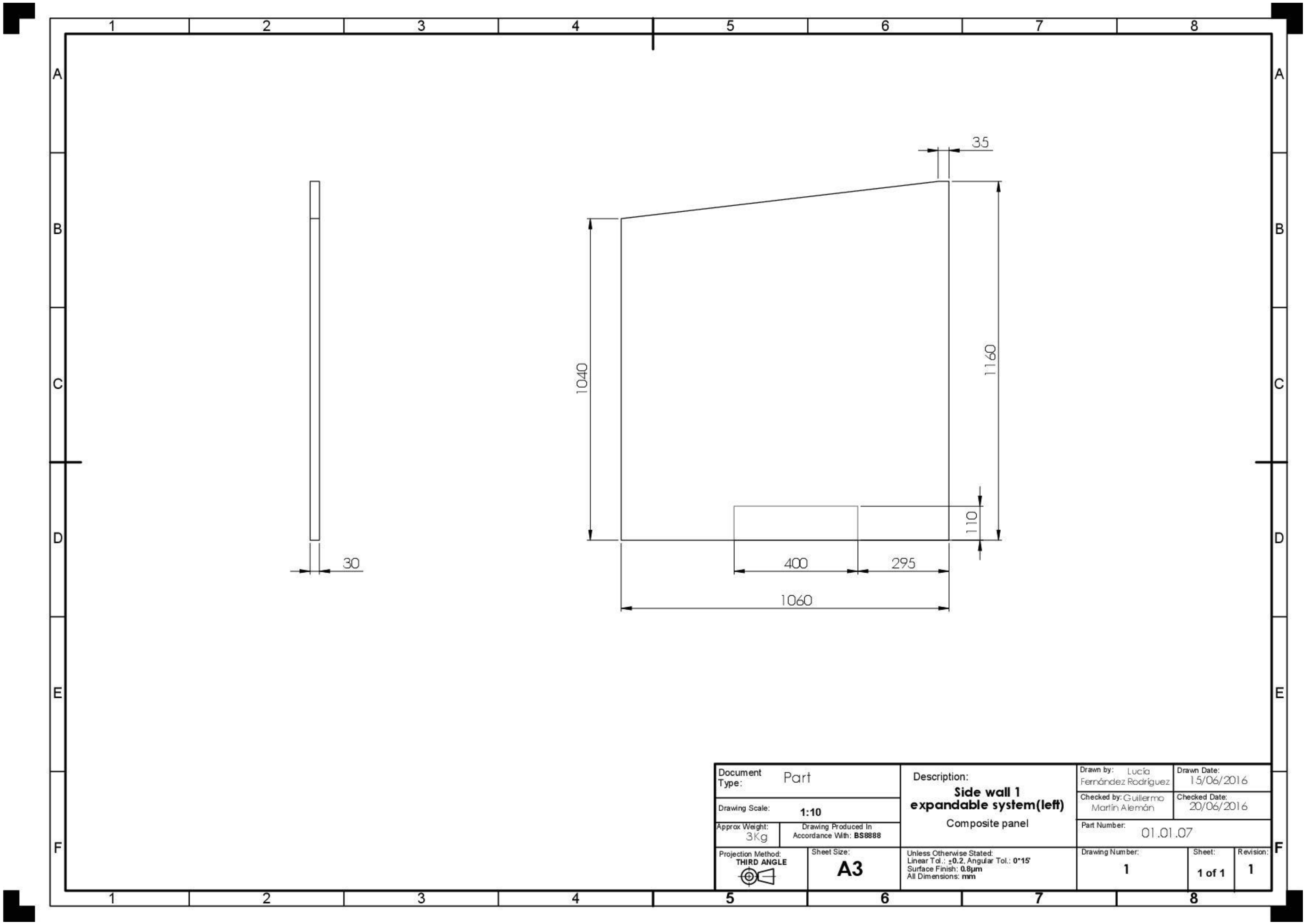
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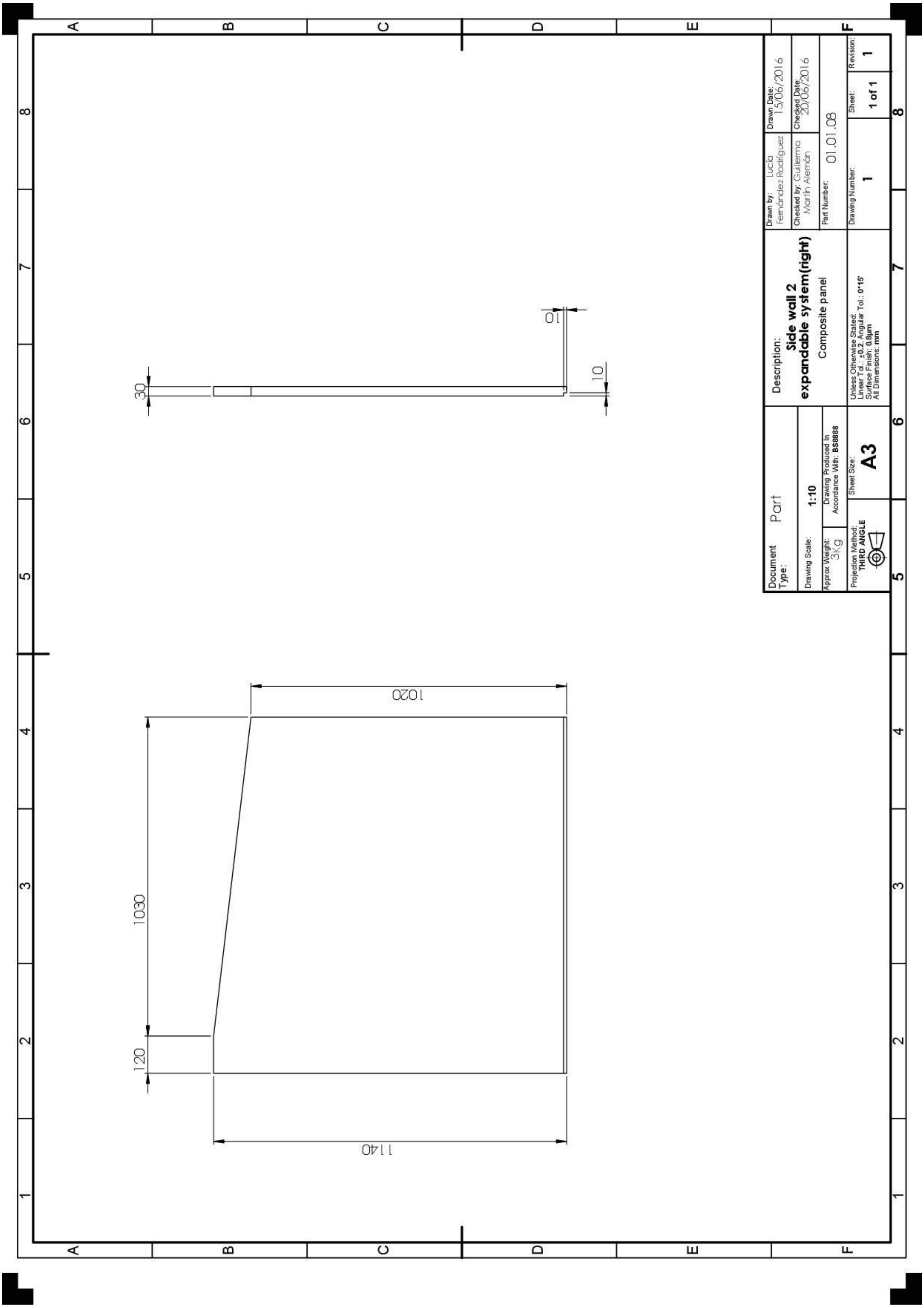
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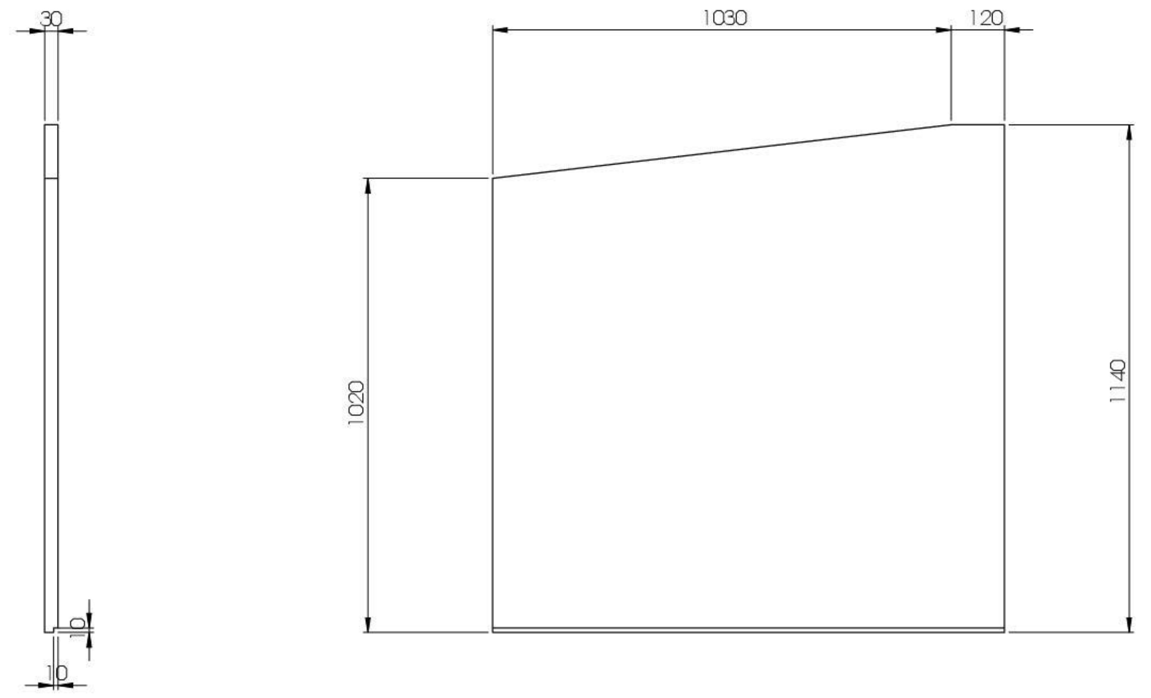

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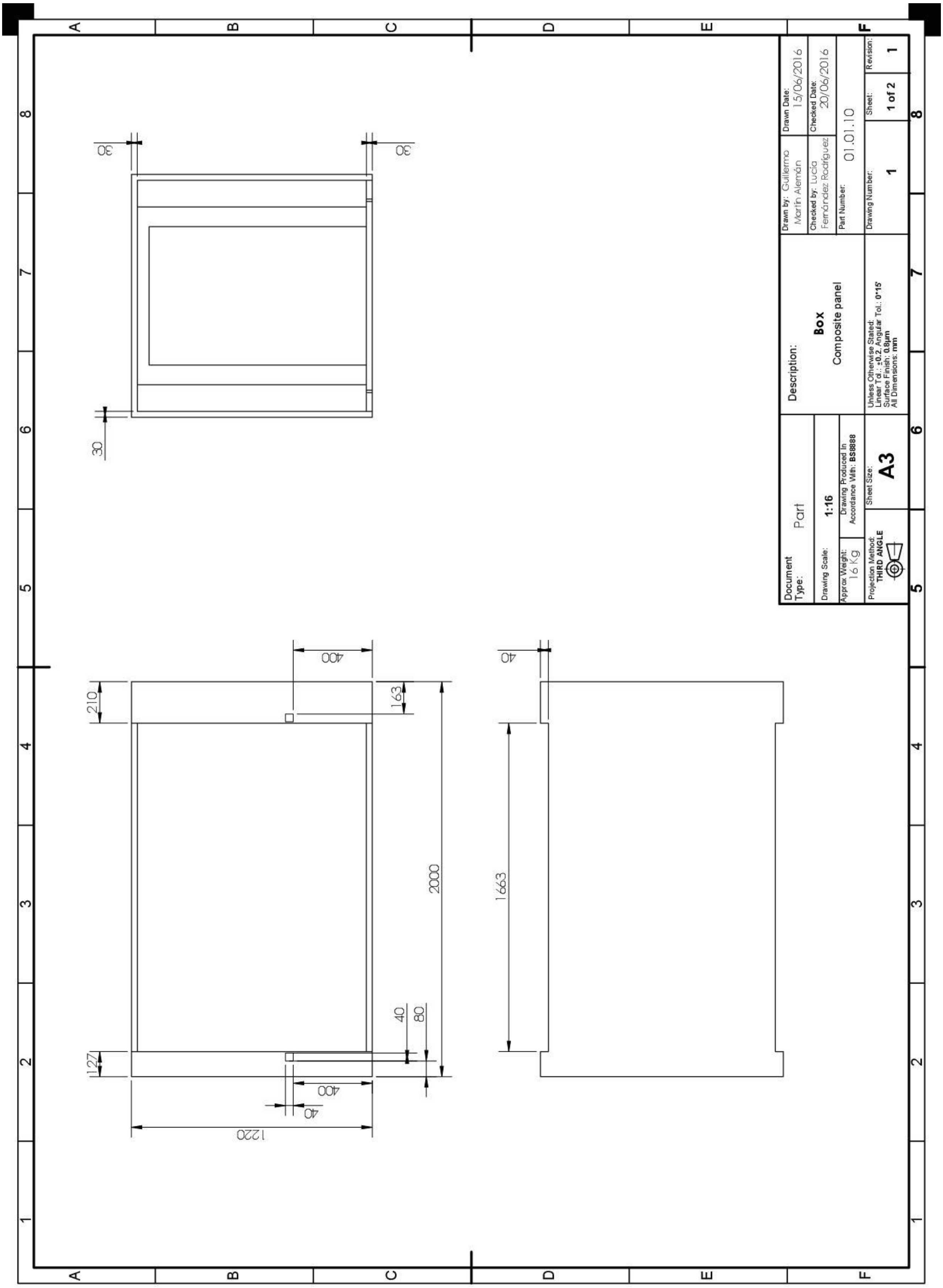
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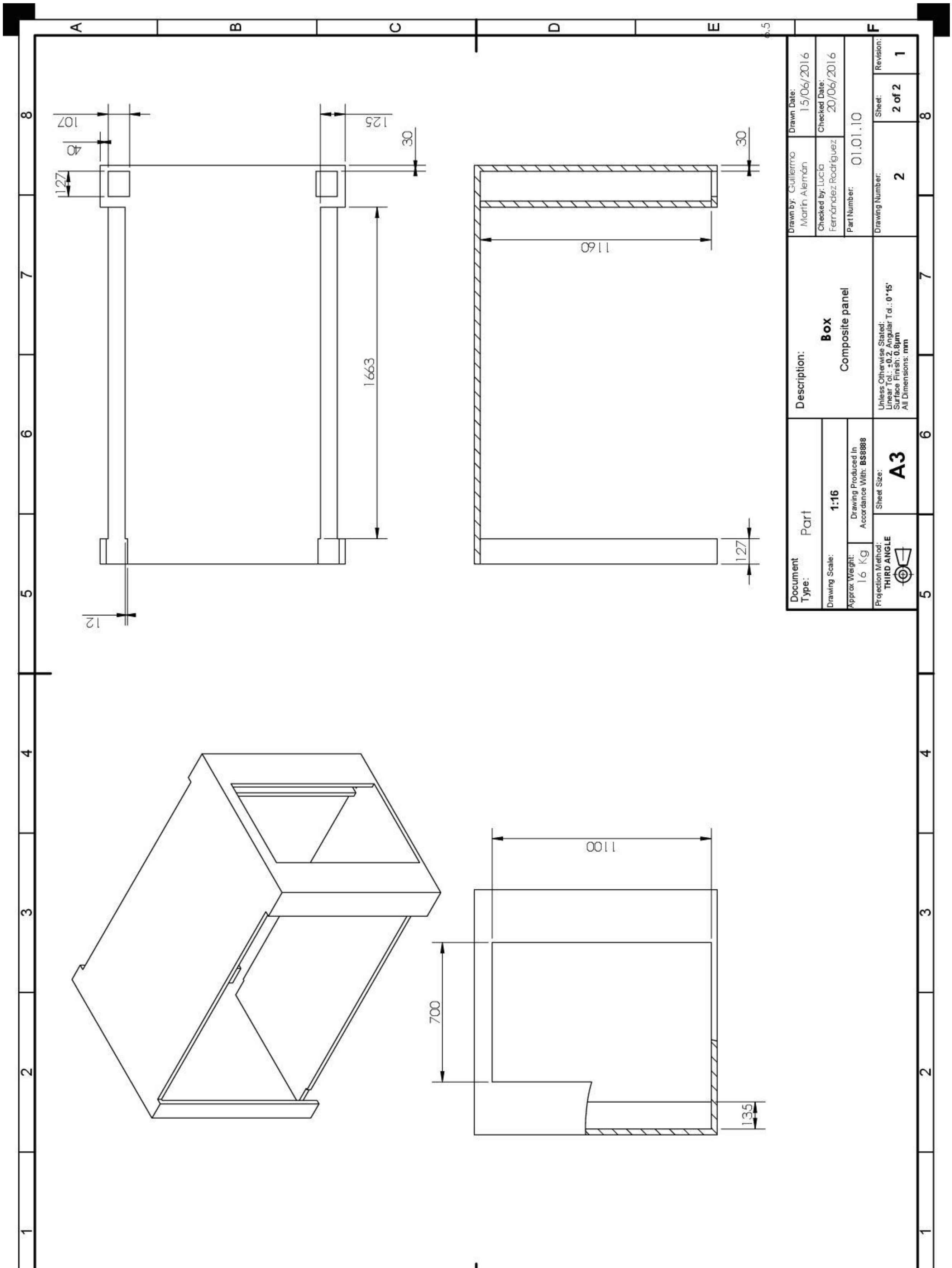

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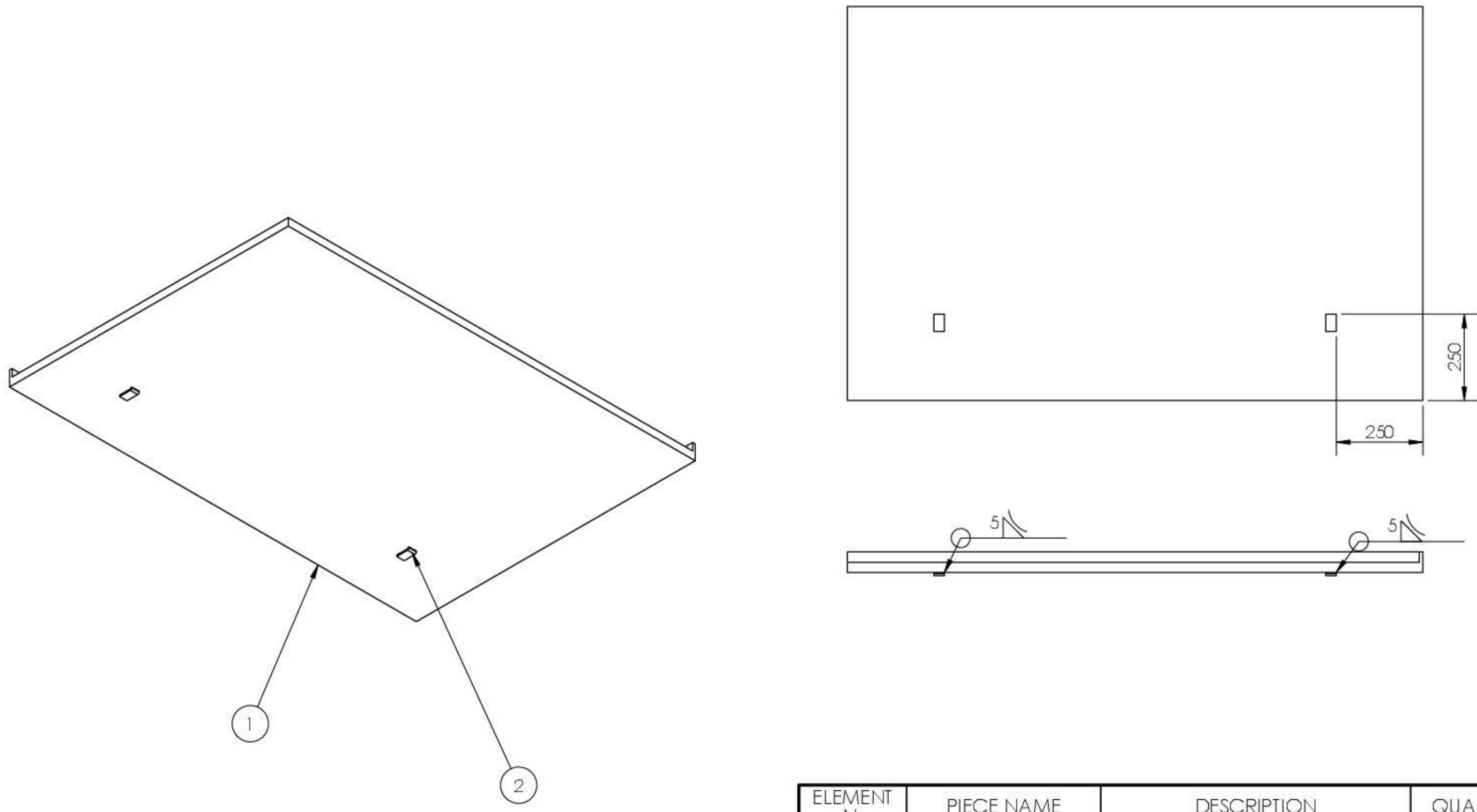

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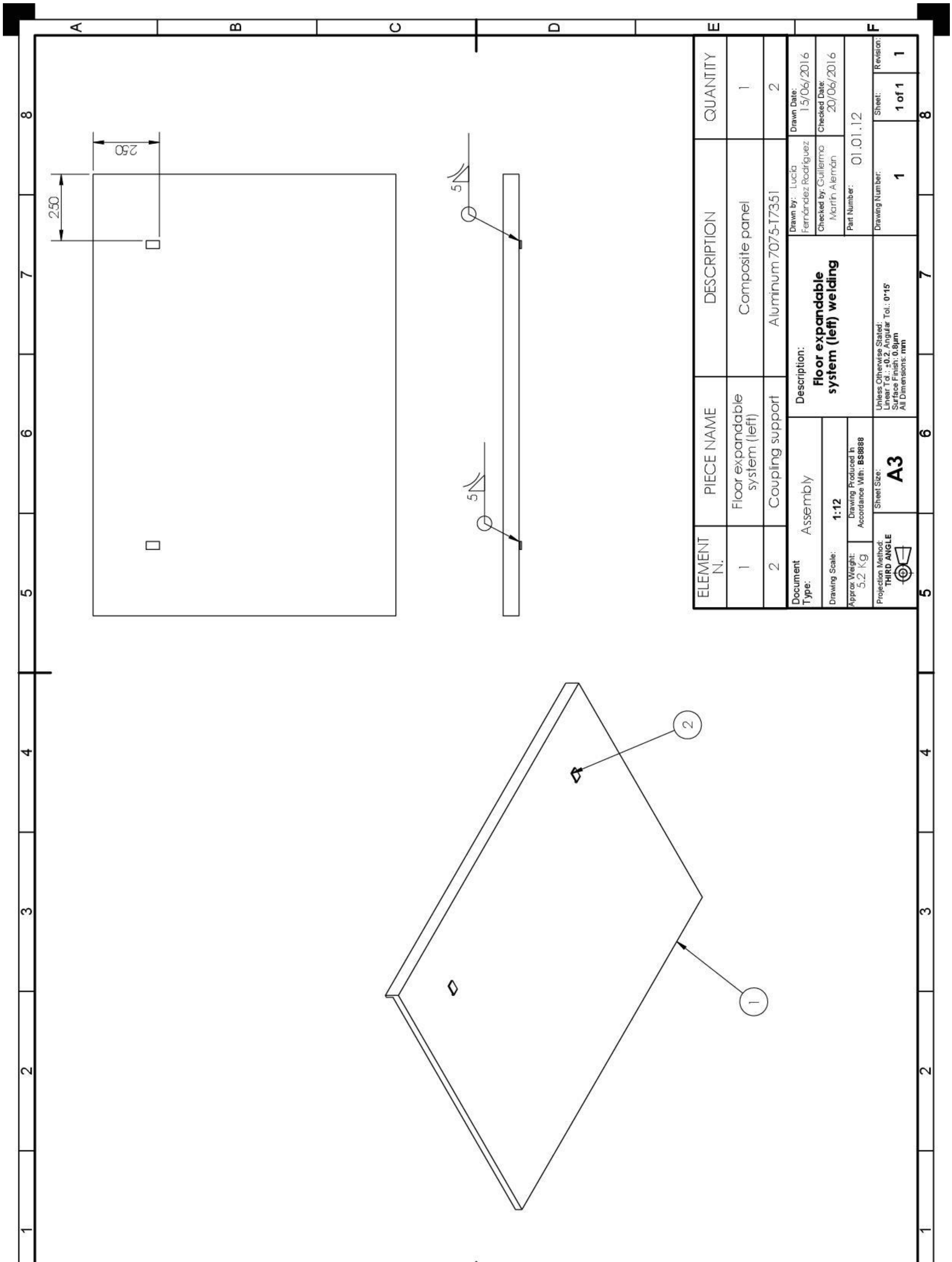

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QUANTITY
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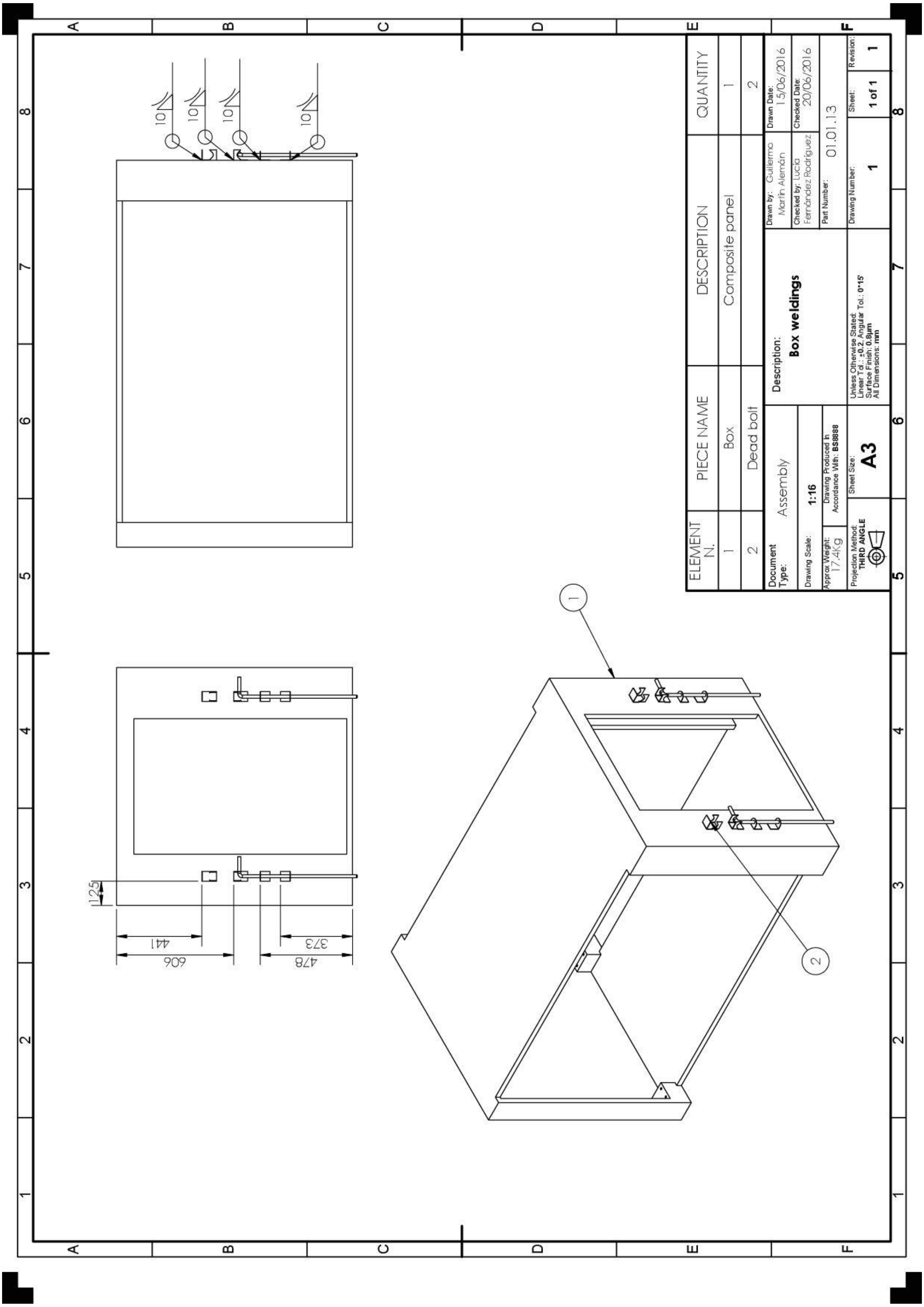
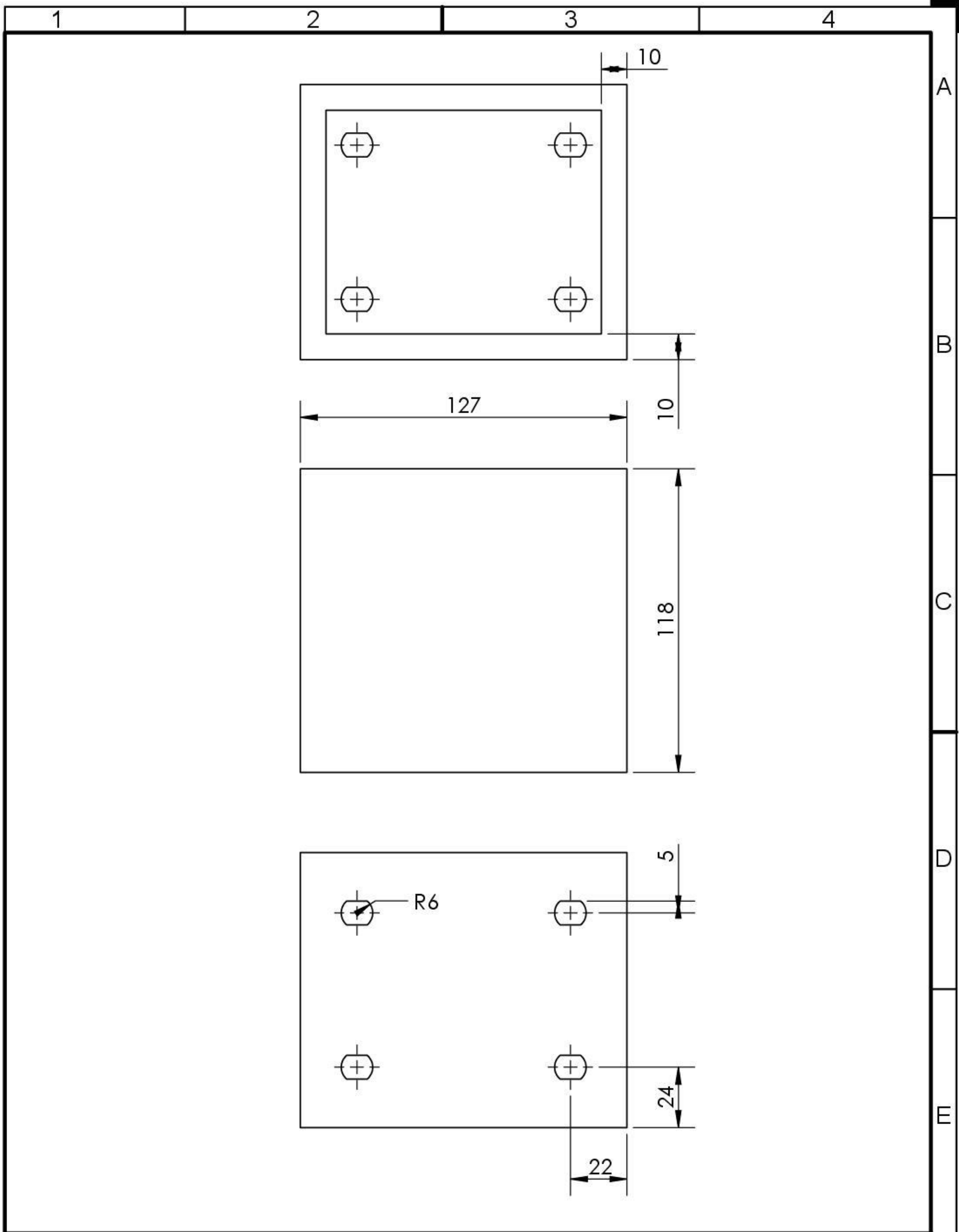
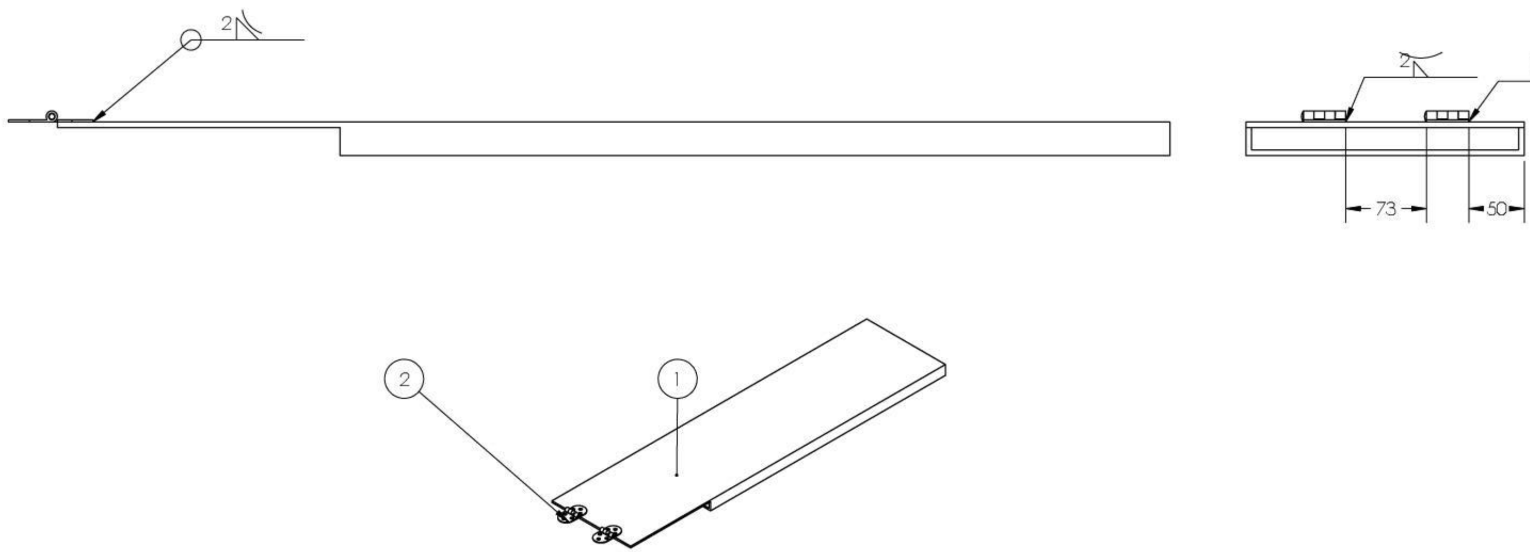
Drawn by: Lucía Fernández Rodríguez
Drawn Date: 15/06/2016
Checked by: Guillermo Martín Alemán
Checked Date: 20/06/2016
Part Number:
01.01.12
Projection Method: THIRD ANGLE
Sheet Size:
A3
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Drawing Number:
1
Sheet:
1 of 1
Revision:
1


ELEMENT N.
PIECE NAME
DESCRIPTION
QUANTITY
1
Box
Composite panel
1
2
Dead bolt
2
Document Type:
Assembly
Description:
Box weldings
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Drawing Scale: 1:16
Approx Weight: 17.4kg
Drawing Produced in Accordance With: BS8888
Part Number: 01.01.13
Projection Method: THIRD ANGLE
Sheet Size: A3
Unless Otherwise Stated: Linear Tol.: ±0.2 Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Drawing Number: 1
Sheet: 1 of 1
Revision: 1
125
441
606
373
478
10

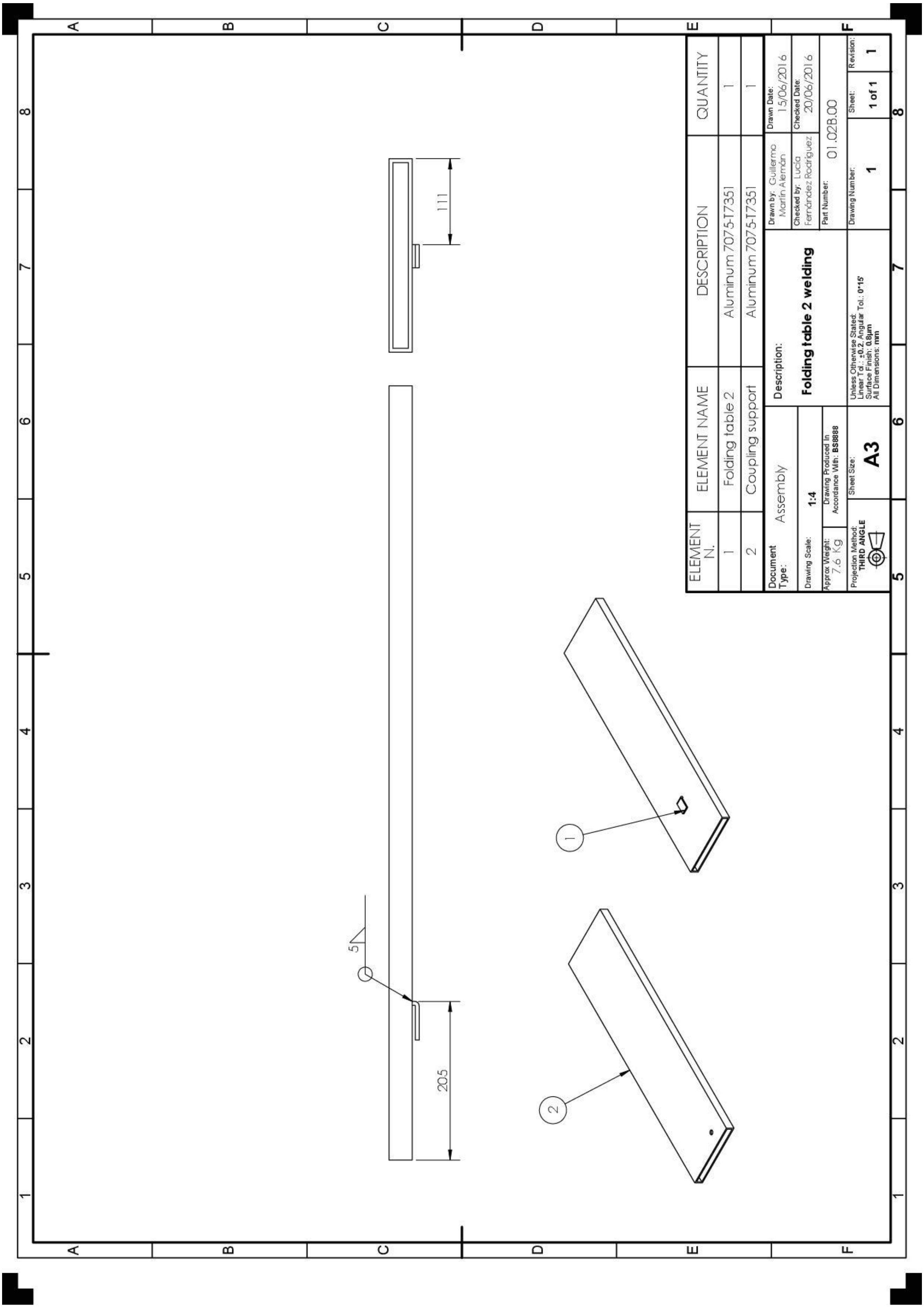


Document Type: Part		Description:	Drawn by: Lucía Fernández Rodríguez	Drawn Date: 15/06/2016	
Drawing Scale: 1:2		**Wheel box**	Checked by: Guillermo Martín Alemán	Checked Date: 20/06/2016	
Approx Weight: 2 Kg	Drawing Produced In Accordance With: **BS8888**	Aluminum 7075-T7351	Part Number: 01.01.14		
Projection Method: **THIRD ANGLE**	Sheet Size: **A4**	Unless Otherwise Stated: Linear Tol.: **±0.2**, Angular Tol.: **0°15'** Surface Finish: **0.8µm** All Dimensions: **mm**	Drawing Number: 1	Sheet: **1 of 1**	Revision: 1

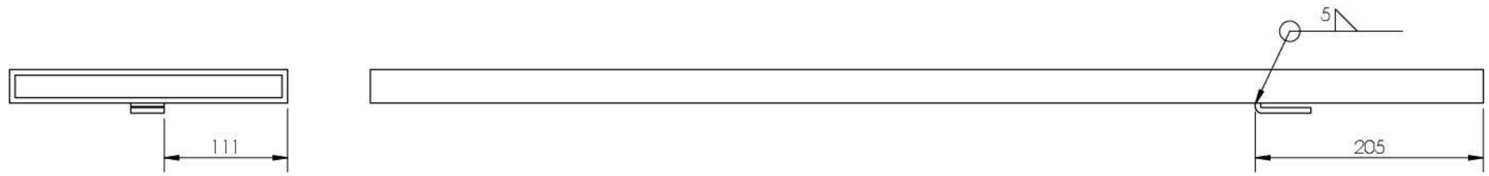


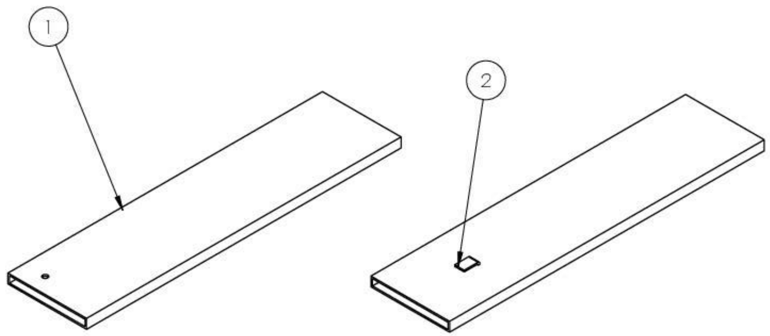
ELEMENT N.	PIECE NAME	DESCRIPTION	QUANTITY
1	Folding table 1	Aluminum 7075-T7351	1
2	Hinge 1	Aluminum 7075-T7351	2

Document Type: Assembly		Description: Folding table 1 welding	Drawn by: Guillermo Martín Alemán	Drawn Date: 15/06/2016
Drawing Scale: 1:4			Checked by: Lucía Fernández Rodríguez	Checked Date: 20/06/2016
Approx Weight: 6.5 Kg	Drawing Produced In Accordance With: BS8888		Part Number: 01.02A.00	
Projection Method: THIRD ANGLE	Sheet Size: A3	Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8μm All Dimensions: mm	Drawing Number: 1	Sheet: 1 of 1 · Revision: 1



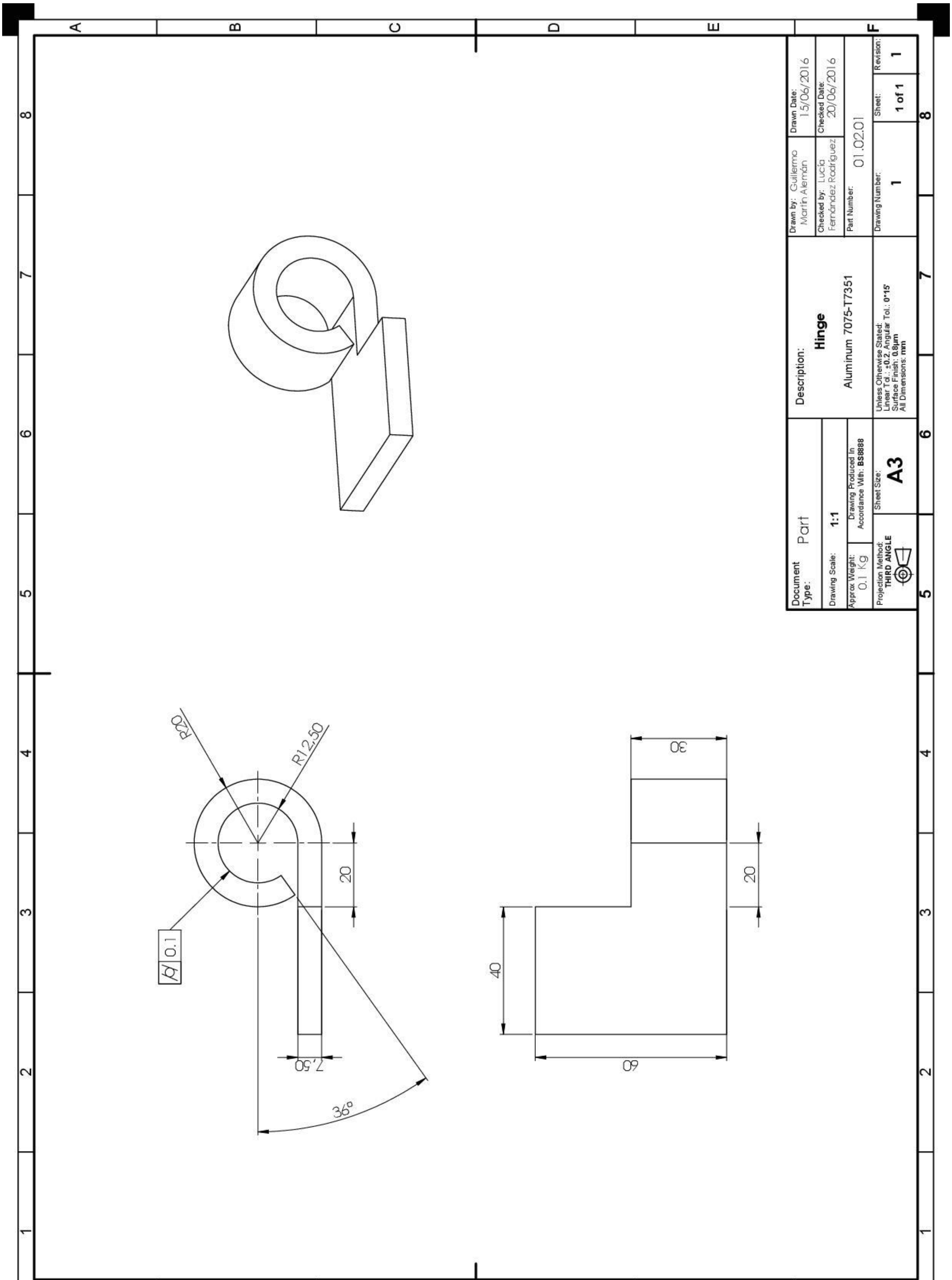
ELEMENT N.
ELEMENT NAME
DESCRIPTION
QUANTITY
1
Folding table 2
Aluminum 7075-T7351
1
2
Coupling support
Aluminum 7075-T7351
1
Document Type:
Assembly
Description:
Folding table 2 welding
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Drawing Scale: 1:4
Part Number: 01.02B.00
Approx Weight: 7.6 Kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Drawing Number: 1
Sheet: 1 of 1
Revision: 1
111
205
5
1
2



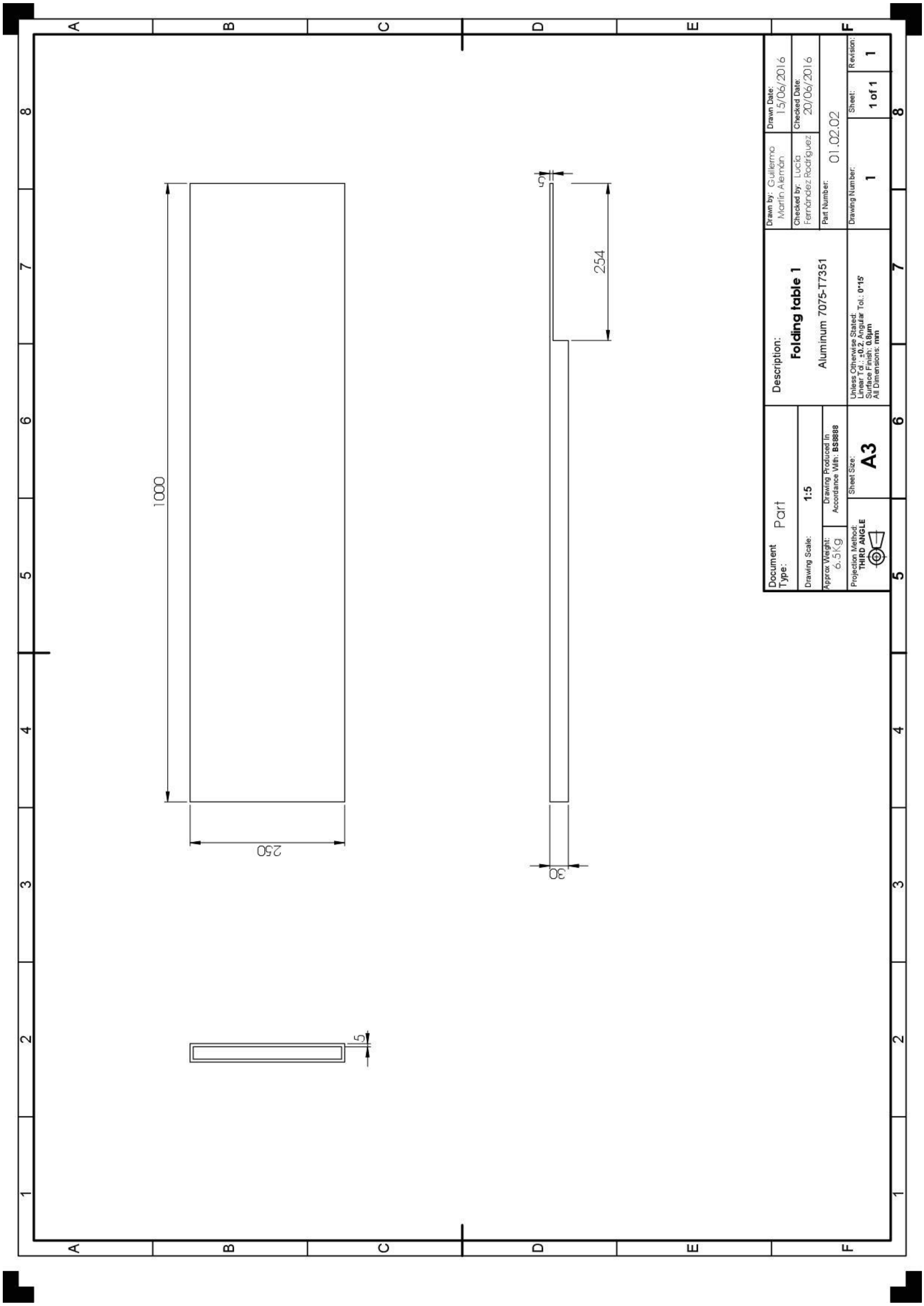


ELEMENT N.	PIECE NAME	DESCRIPTION	QUANTITY
2	Folding table 3	Aluminum 7075-T7351	1
1	Coupling support	Aluminum 7075-T7351	1

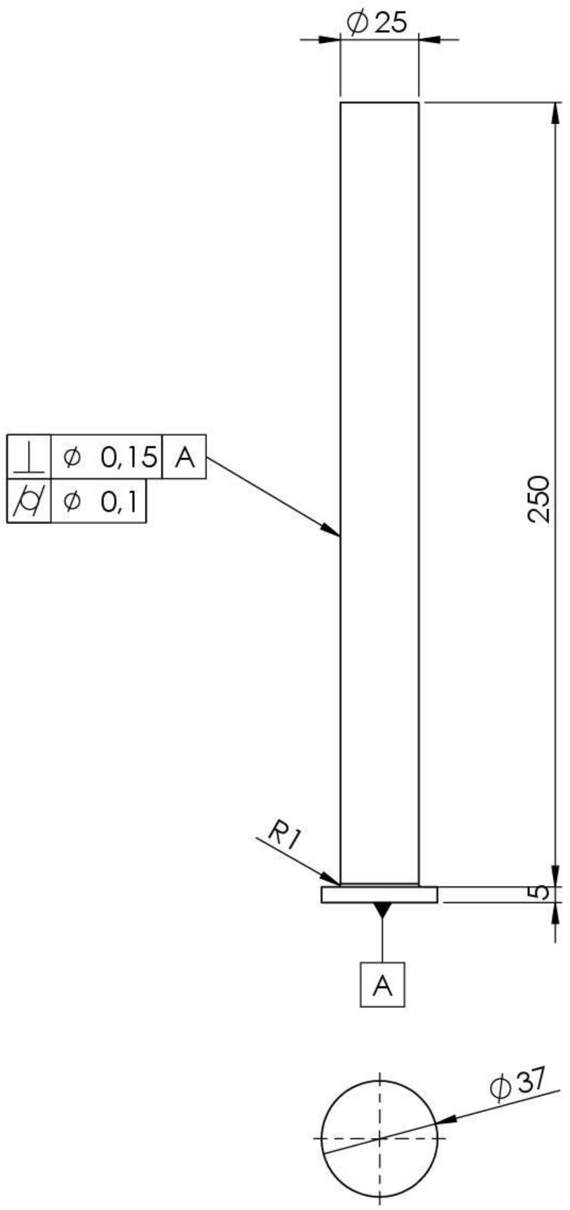
Document Type: Assembly	Description:	Drawn by: Guillermo Martín Alemán	Drawn Date: 15/06/2016	
Drawing Scale: 1:4	**Folding table 3 welding**	Checked by: Lucía Fernández Rodríguez	Checked Date: 20/06/2016	
Approx Weight: 7.6Kg / Drawing Produced In Accordance With: **BS8888**		Part Number: 01.02C.00		
Projection Method: **THIRD ANGLE** / Sheet Size: **A3**	Unless Otherwise Stated: Linear Tol.: **±0.2**, Angular Tol.: **0°15'** Surface Finish: **0.8µm** All Dimensions: **mm**	Drawing Number: **1**	Sheet: **1 of 1**	Revision: **1**



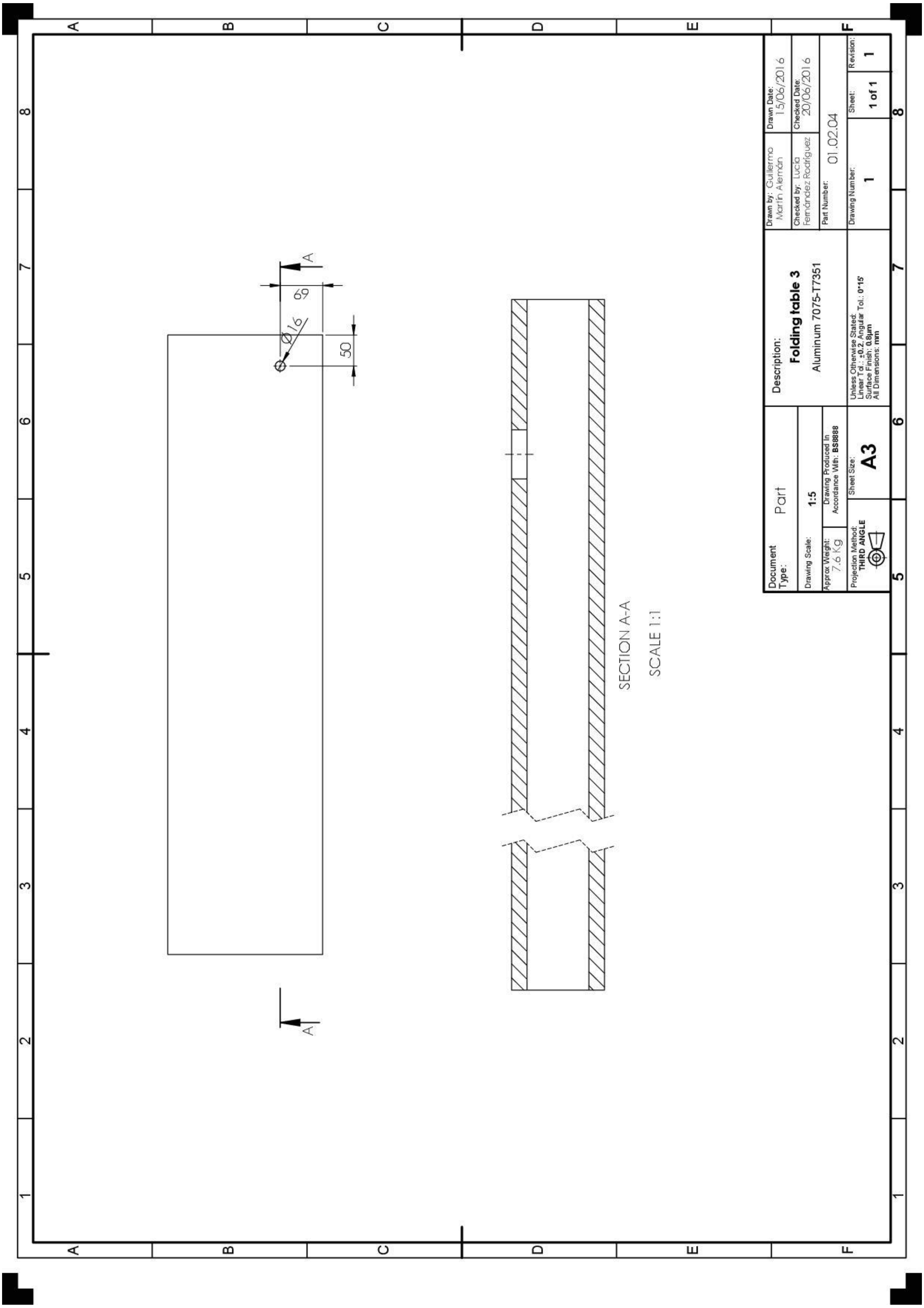
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.01
Drawing Number: 1
Sheet: 1 of 1
Revision: 1
Description: Hinge
Aluminum 7075-T7351
Unless Otherwise Stated: Linear Tol.: ±0.2 Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Document Type: Part
Drawing Scale: 1:1
Approx Weight: 0.1 Kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
R20
R12,50
0.1
20
7,50
36°
30
20
40
60

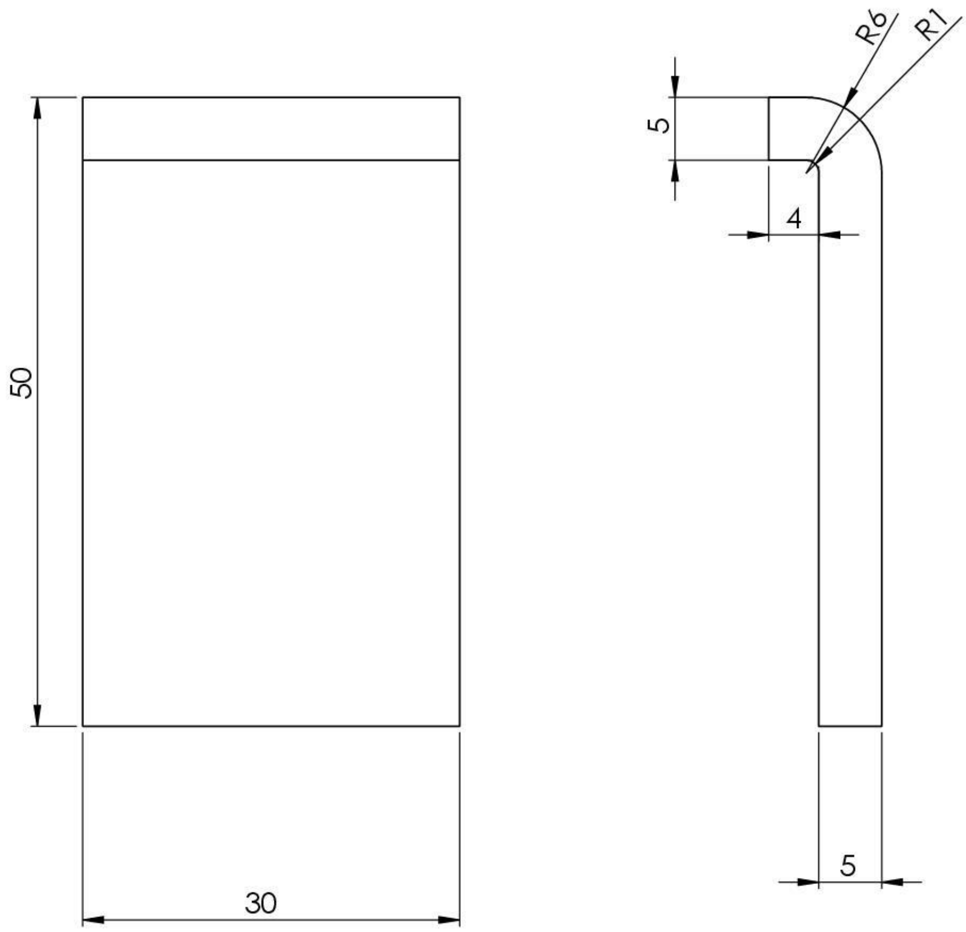


1000
250
254
5
30
5
Document Type: Part
Drawing Scale: 1:5
Approx Weight: 6.5kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
Description:
Folding table 1
Aluminum 7075-T7351
Unless Otherwise Stated: Linear Tol.: ±0.2 Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.02
Drawing Number: 1
Sheet: 1 of 1
Revision: 1

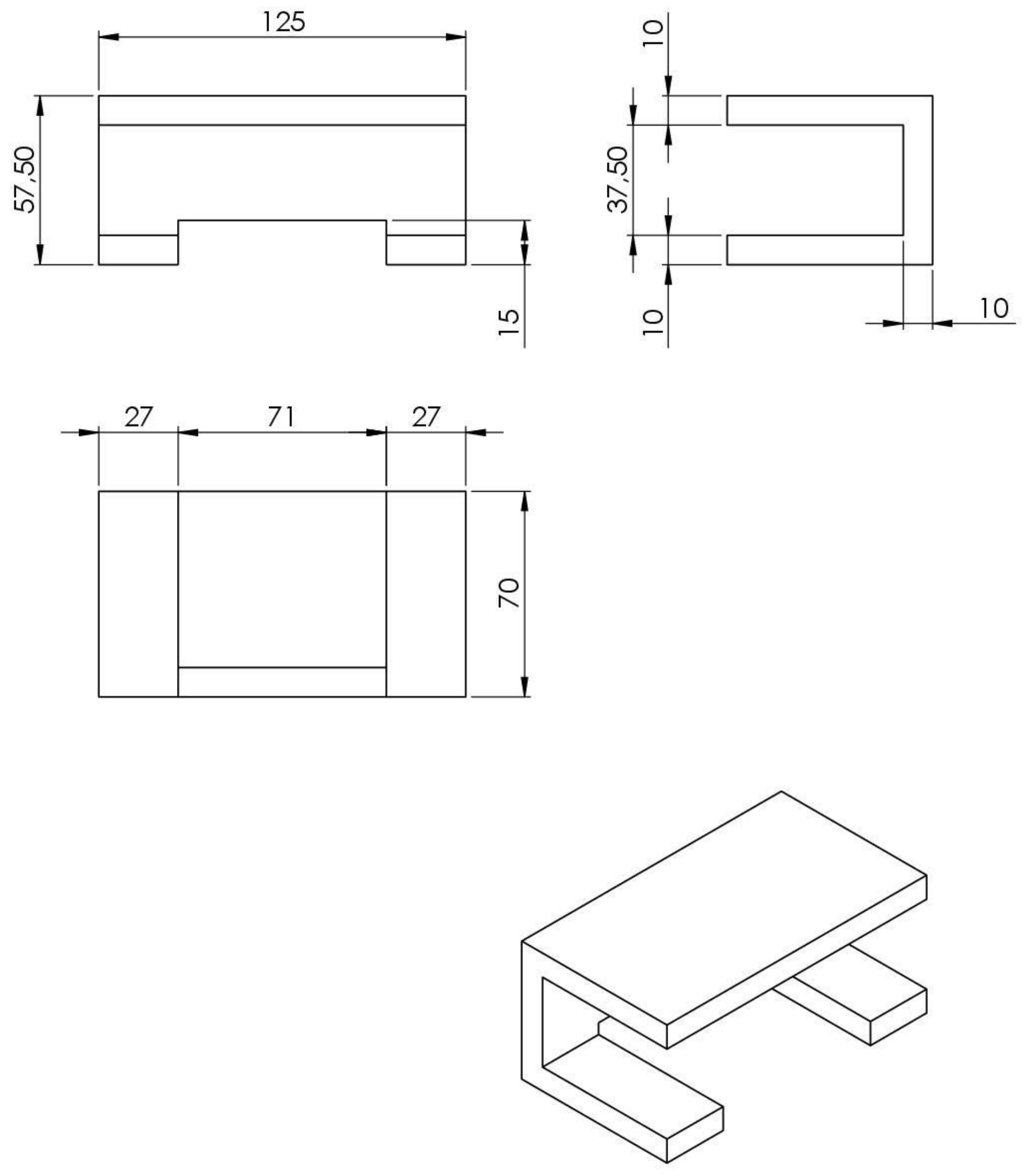


Document Type: Part	Description: Pin	Drawn by: Guillermo Martín Alemán	Drawn Date: 15/06/2016
Drawing Scale: 1:2	Aluminum 7075-T7351	Checked by: Lucía Fernández Rodríguez	Checked Date: 20/06/2016
Approx Weight: 0.35Kg / Drawing Produced In Accordance With: **BS8888**		Part Number: 01.02.03	
Projection Method: THIRD ANGLE / Sheet Size: **A4**	Unless Otherwise Stated: Linear Tol.: ±**0.2**, Angular Tol.: **0°15'** Surface Finish: **0.8μm** All Dimensions: **mm**	Drawing Number: 1	Sheet: **1 of 1** / Revision: 1


SECTION A-A
SCALE 1:1
Ø16
69
50
A
Document Type: Part
Drawing Scale: 1:5
Approx Weight: 7.6 Kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
Description: Folding table 3
Aluminum 7075-T7351
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15'
Surface Finish: 0.8µm
All Dimensions: mm
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.04
Drawing Number: 1
Sheet: 1 of 1
Revision: 1



Document Type: Part		Description: **Coupling support** Aluminum 7075-T7351	Drawn by: Guillermo Martín Alemán	Drawn Date: 15/06/2016	
Drawing Scale: **2:1**			Checked by: Lucía Fernández Rodríguez	Checked Date: 20/06/2016	
Approx Weight: 0.022 Kg	Drawing Produced In Accordance With: **BS8888**		Part Number: 01.02.05		
Projection Method: **THIRD ANGLE**	Sheet Size: **A4**	Unless Otherwise Stated: Linear Tol.: ±**0.2**, Angular Tol.: **0°15'** Surface Finish: **0.8µm** All Dimensions: **mm**	Drawing Number: **1**	Sheet: **1 of 1**	Revision: **1**



Document Type: Part

Drawing Scale: **1:2**

Approx Weight: 0.5 Kg

Drawing Produced In Accordance With: **BS8888**

Description:

Subjection

Aluminum 7075-T7351

Drawn by: Guillermo Martín Alemán

Drawn Date: 15/06/2016

Checked by: Lucía Fernández Rodríguez

Checked Date: 20/06/2016

Part Number: 01.02.06

Projection Method: **THIRD ANGLE**

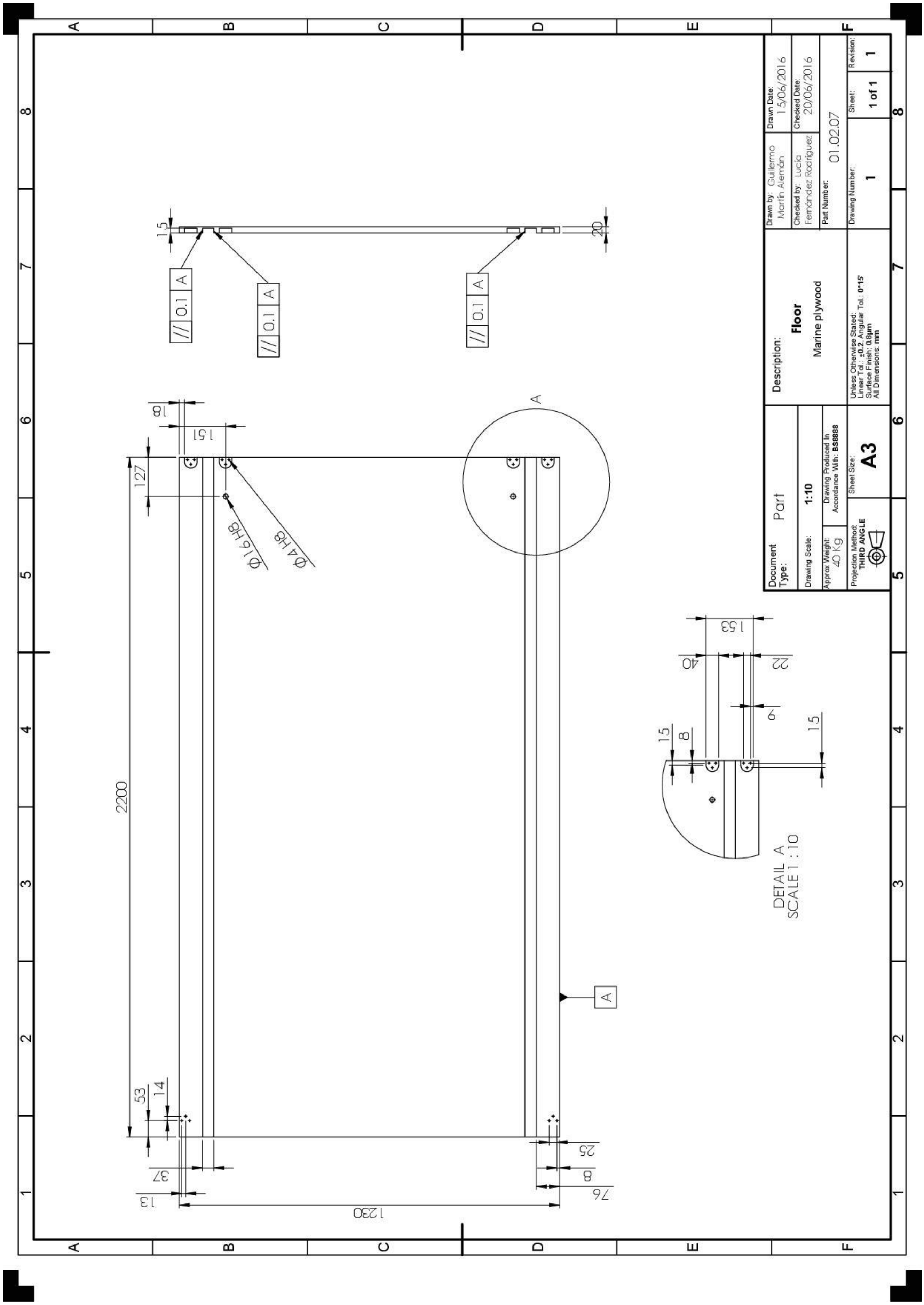
Sheet Size: **A4**

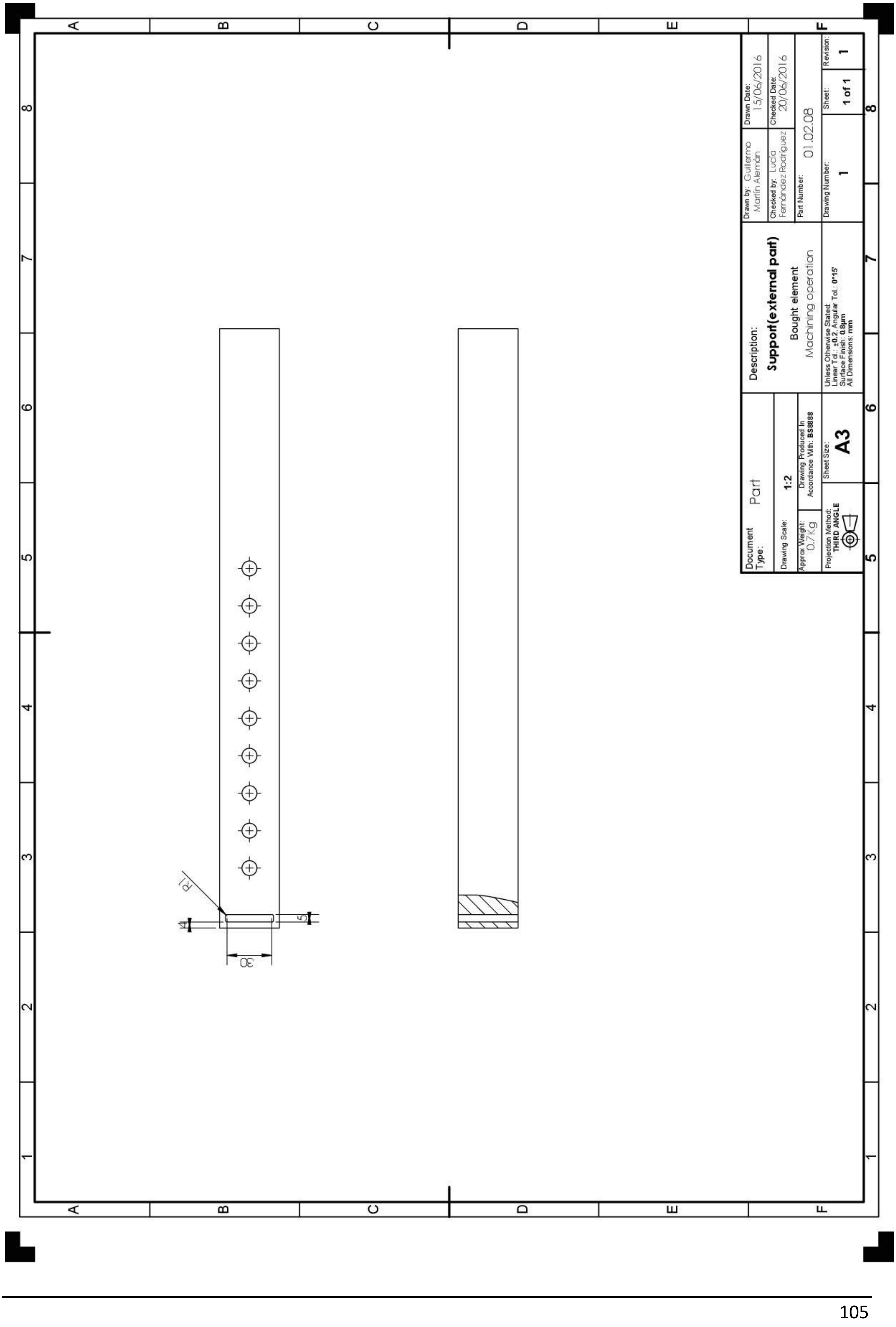
Unless Otherwise Stated:
Linear Tol.: **±0.2**, Angular Tol.: **0°15'**
Surface Finish: **0.8µm**
All Dimensions: **mm**

Drawing Number: 1

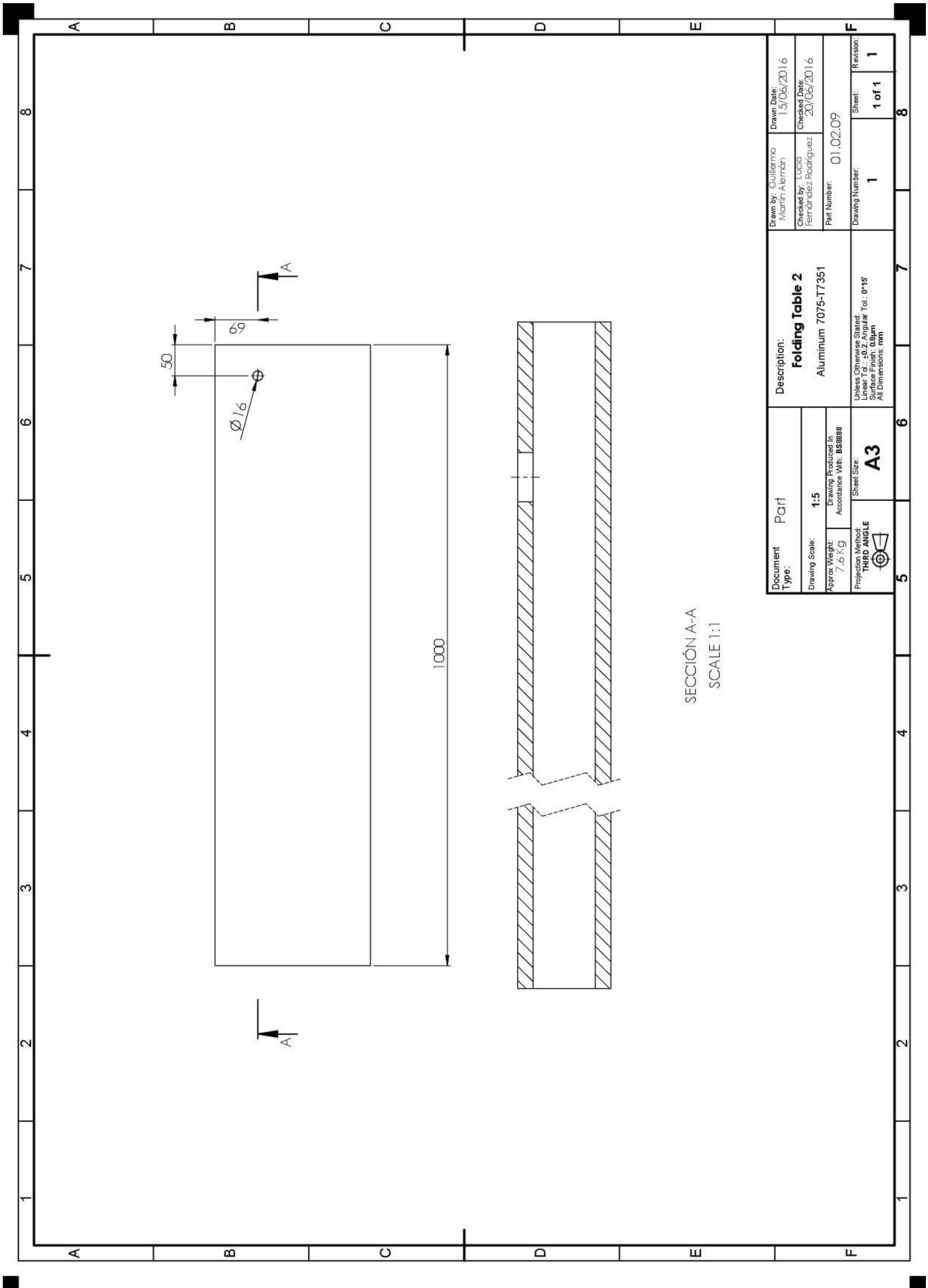
Sheet: **1 of 1**

Revision: 1


Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.07
Sheet: 1 of 1
Revision: 1
Drawing Number: 1
Description:
Floor
Marine plywood
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15'
Surface Finish: 0.8µm
All Dimensions: mm
Document Type: Part
Drawing Scale: 1:10
Approx Weight: 40 Kg
Drawing Produced In Accordance With: BS8888
Sheet Size: A3
Projection Method: THIRD ANGLE
DETAIL A
SCALE 1 : 10



Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.08
Drawing Number: 1
Sheet: 1 of 1
Revision: 1
Description:
Support(external part)
Bought element
Machining operation
Unless Otherwise Stated:
Linear Tol.: ±0.2, Angular Tol.: 0°15'
Surface Finish: 0.8µm
All Dimensions: mm
Document Type: Part
Drawing Scale: 1:2
Approx Weight: 0.7Kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
R1
4
5
30



A
B
C
D
E
F
1
2
3
4
5
6
7
8
A
69
50
Ø16
1000
SECCIÓN A-A
SCALE 1:1
Document Type: Part
Drawing Scale: 1:5
Approx Weight: 7.6 Kg
Drawing Produced In Accordance With: BS8888
Projection Method: THIRD ANGLE
Sheet Size: A3
Description: Folding Table 2
Aluminum 7075-T7351
Unless Otherwise Stated: Linear Tol.: ±0.2, Angular Tol.: 0°15' Surface Finish: 0.8µm All Dimensions: mm
Drawn by: Guillermo Martín Alemán
Drawn Date: 15/06/2016
Checked by: Lucía Fernández Rodríguez
Checked Date: 20/06/2016
Part Number: 01.02.09
Drawing Number: 1
Sheet: 1 of 1
Revision: 1