Rear Steering Linkage Mechanism

06-85-230 – Advanced Engineering and Design

Department of Mechanical, Automotive and Materials Engineering

Section # 2

Group # 2

Team # 1

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ABSTRACT

The purpose of this advanced design project was to model a rear steering wheel assembly of a car with the help of *Catia V5R21*, a 3D modeling software for everyday applications. The problem of this project dealt typically with understanding if the dimensions and approaches were correct for each part. In order to coincide all the parts together, everything had to be perfect.

To initiate the project, each member received one or two specific parts to model carefully in the *Part Design* workbench. A guideline with dimensions and isometric views was provided for reference and was used in the modeling process. The parts were then exchanged between members and were checked for their errors, approach and clumsiness before being added to a *Drafting* workbench. Teaching assistants helped to confirm any assumptions made.

After having modeled seven parts, tasks for dimensioning in the *Drafting* workbench were assigned to each group member.

After all the revisions were done, an assembly of all the parts was set up with the help of the *Assembly* workbench to visually portray the rear steering wheel assembly. With these parts all put together, several snapshots were taken to finalize the project.

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1 Introduction

The relationship between dimensions and virtually creating a product is not only inspiring but unique. The methods used to design can indicate both cleanliness and clumsiness. In a practical world factors such as the size of the document, quality of labeled parts and detailed drafts not only help to get a better understanding but meet the client's needs. A total of seven parts were modeled in this project with the help of the *Part Design* workbench for the Rear Steering Wheel Assembly *Product*. The dimensions were in metric (centimeters) and only two materials, steel and rubber, were applied to the specific parts.

The basic aim of steering is to ensure that the wheels are pointing in the desired directions. The components used in the linkage mechanism are rear frame, center arm, knuckle arms, rods, wheel and tire. Each component has its own dimensions. Using these dimensions on the program CATIA, we designed the Rear Steering linkage Mechanism. After designing each component separately, the 'coincide' command was used in CATIA. This report explains in depth as to how each may have been modeled.

2 Component Design

The following are each of the individual parts that were modeled in this project. Three parts are simply copies of one another and as a result are not represented twice. These are the Tie Rod(s), Wheel(s) and Tire(s). Both the Knuckle arms are very similar with each other and as such only one is explain in detail.

2.1 – Frame Rear

2.1.1 3D Model

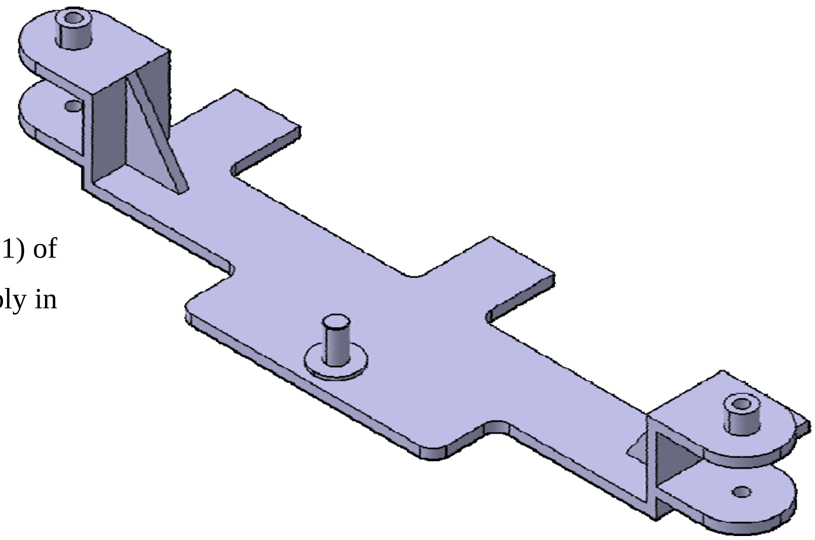


Figure 1: Frame Rear (Part 1) of the Steering Wheel Assembly in its isometric view without materials applied (steel).

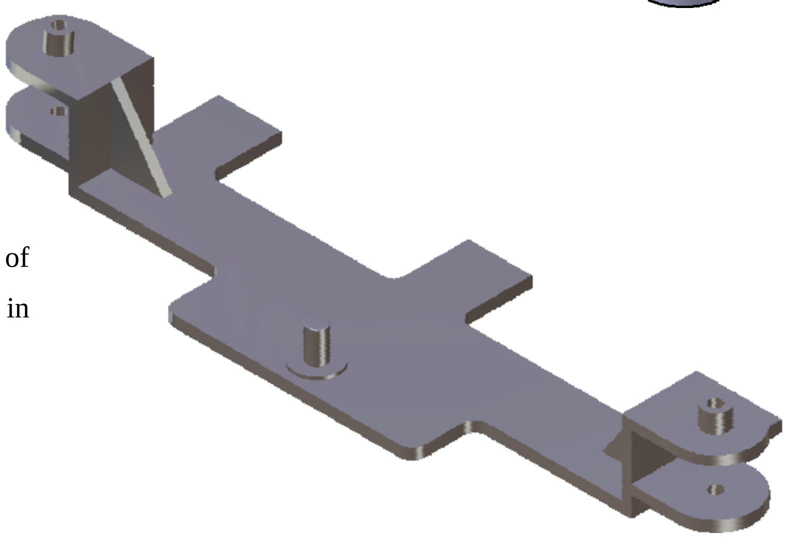
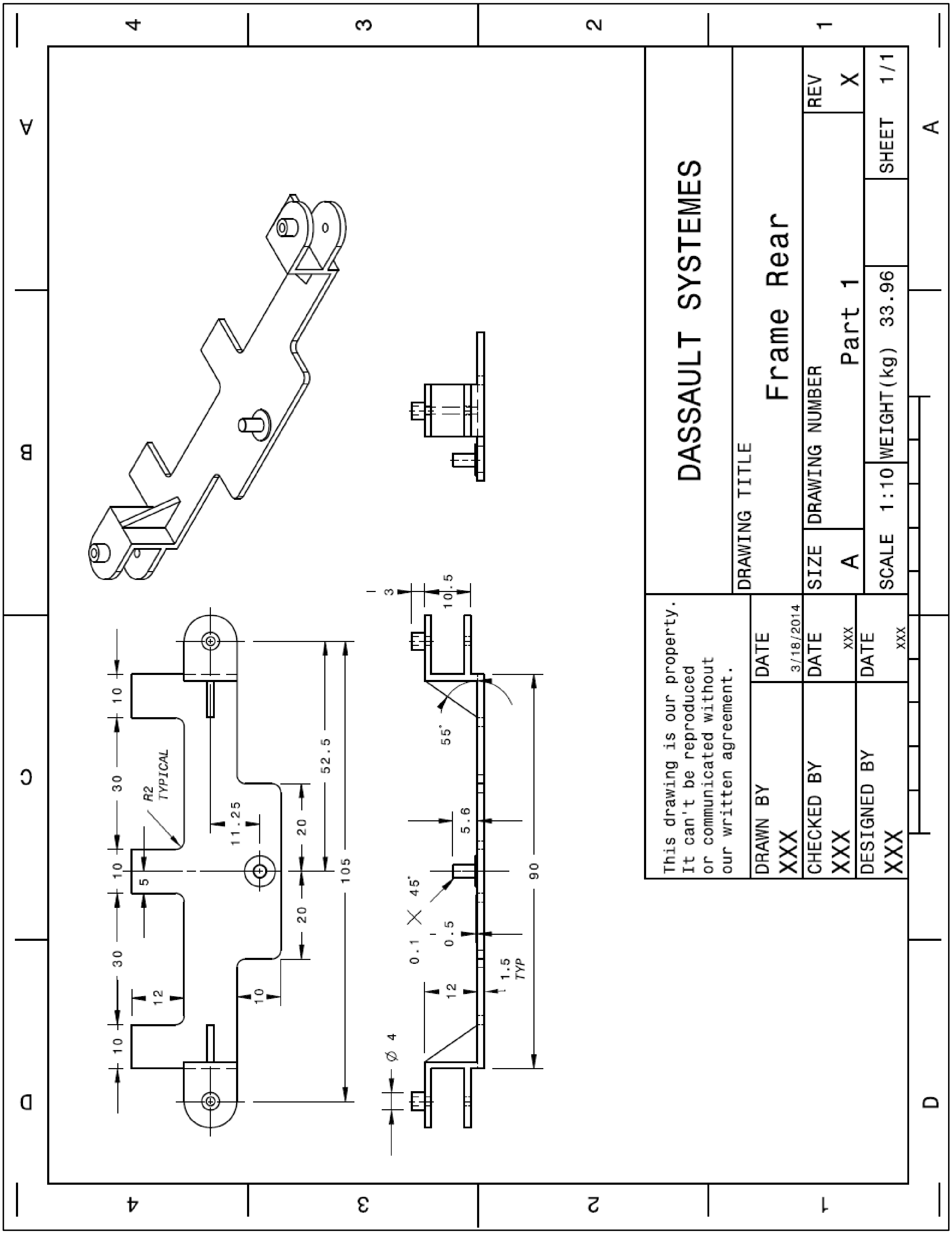


Figure 2: Frame Rear (Part 1) of the Steering Wheel Assembly in its isometric view with its materials applied (steel).

2.1.2 Orthographic views



2.1.3 Other comments/calculations if applicable

This part started out as a sketch on the yz-plane and was separated into several components. The *profile* tool was used to make the sketch and the *constraints* tool was used to properly dimension the required lengths. It was then mirrored on the vertical axis and padded with the help of the *multipad* and *mirror* tools respectively. The thickness of the triangular part (with an angle of 55°) was estimated to be 1.5cm as this was the thickness of the Frame Rear throughout the sketch.

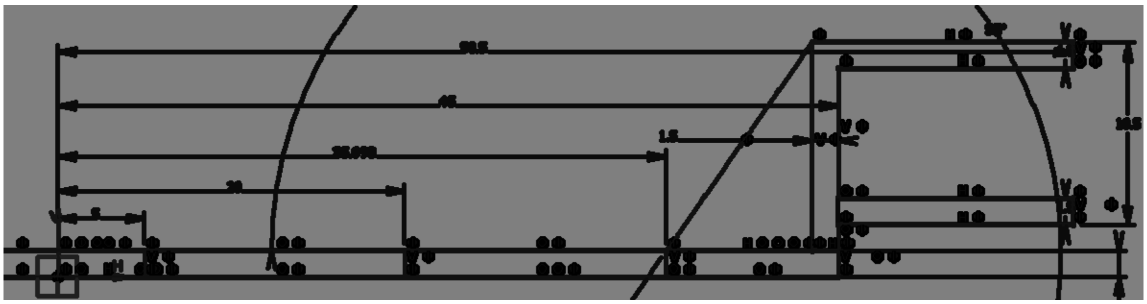


Figure 3: Shows the first sketch that was profiled before mirroring with the vertical axis

After all the pads lengths were calculated properly, a total of 16 edges were *filleted* with a radius of 2 and 6cm. The bigger radius's were applied to the extrusions that would attach to the knuckle arms. Two *pads* were extruded from the highest knuckle-attachable surface of circles with a diameter of 4 cm each. A *thru hole* was then placed in each center of these pads (diameter of 2 cm) to finalize the part before being added to the assembly.

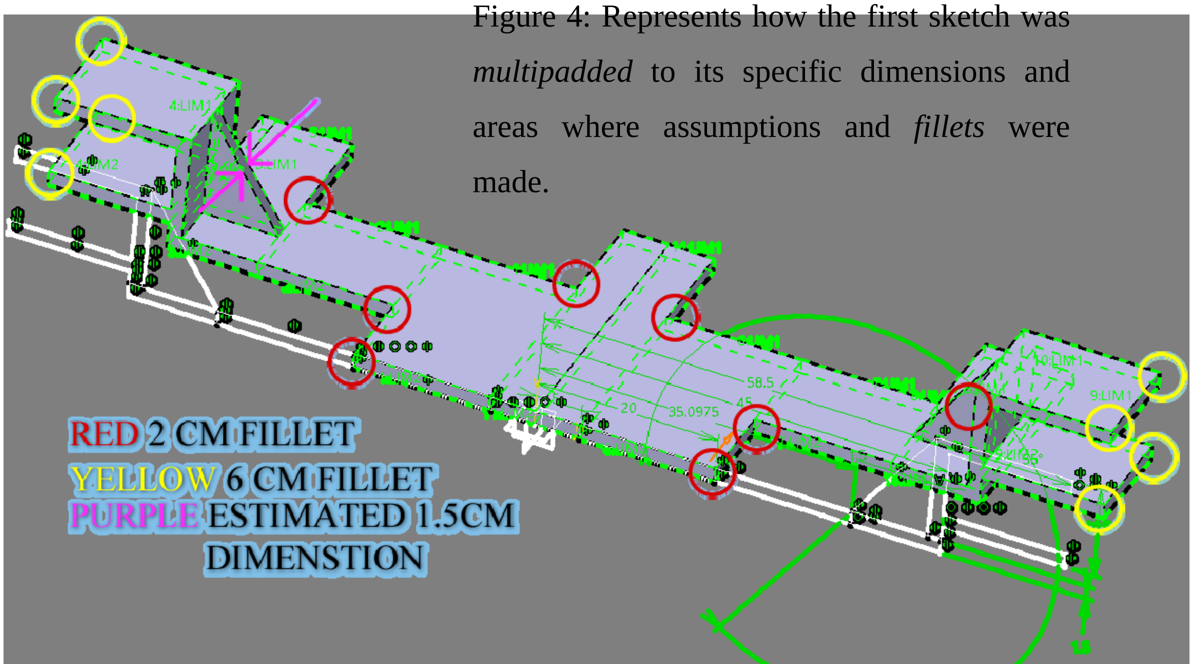


Figure 4: Represents how the first sketch was *multipadded* to its specific dimensions and areas where assumptions and *fillets* were made.

2.2 – Center Arm

2.2.1 3D Model

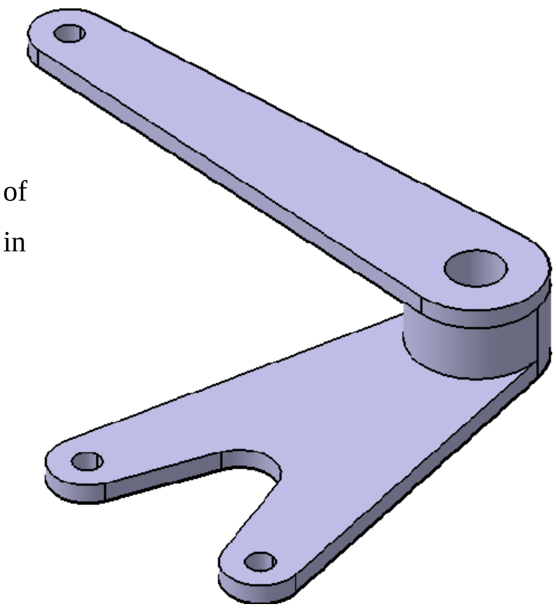


Figure 5: Center Arm (Part 2) of the Steering Wheel Assembly in its isometric view without materials applied (steel).

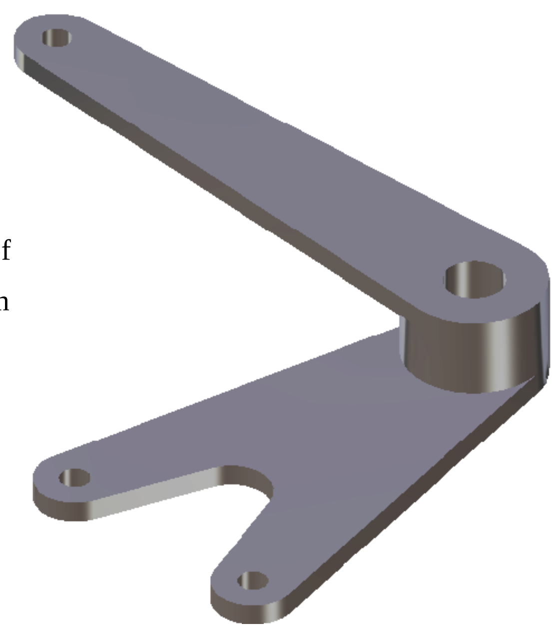
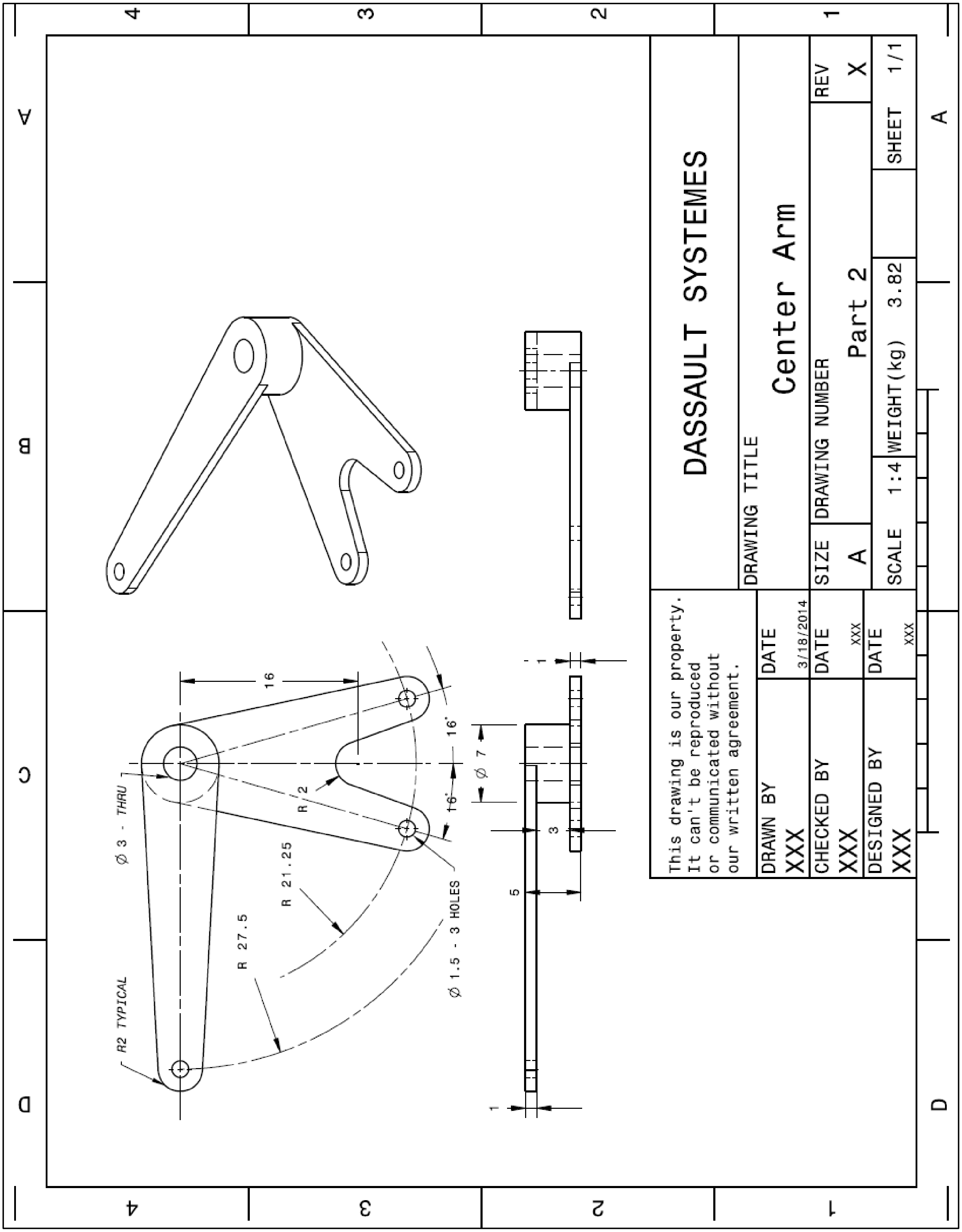


Figure 6: Center Arm (Part 2) of the Steering Wheel Assembly in its isometric view with its materials applied (steel).

2.2.2 Orthographic views



2.2.3 Other comments/calculations if applicable

To initiate this model, a sketch was started form the xy-plane where *construction lines* were created as center points for the two holes (diameter of 1.5cm each) that would attach to them. The two lines were both 16° from the horizontal axis and were long enough so that the other *constructed circle* (radius 21.25cm) was intersecting. Then, three more circles were added to the sketch. Two of them were with a dimension of 2cm while another had a diameter of 7cm (which was placed at the center). The *bi-tangent line* tool was used to connect all the circles together and excess profile was trimmed away with the help of the *trim* tool. It was then *multipadded* with its base thickness of 1cm and the circle with the highest diameter being 5cm.

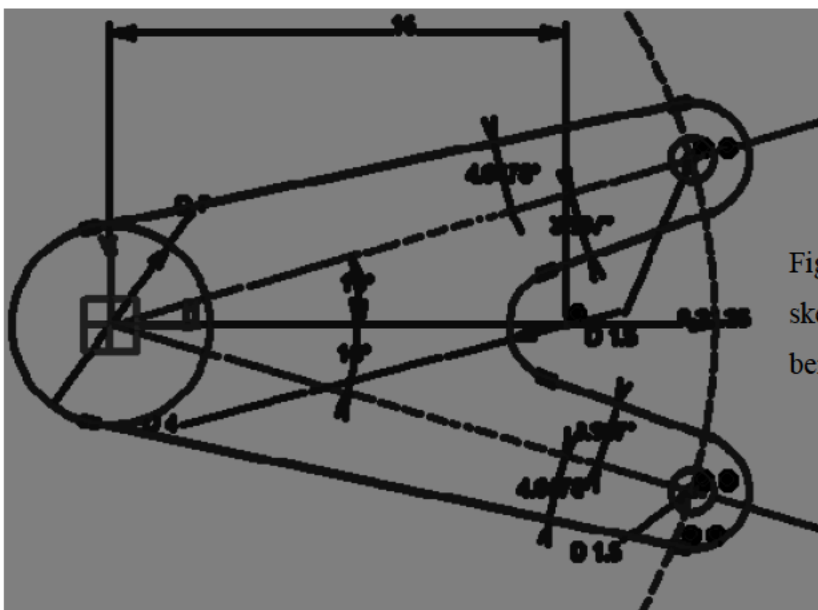


Figure 7: Represents the first sketch of the Center arm before being *multipadded.*

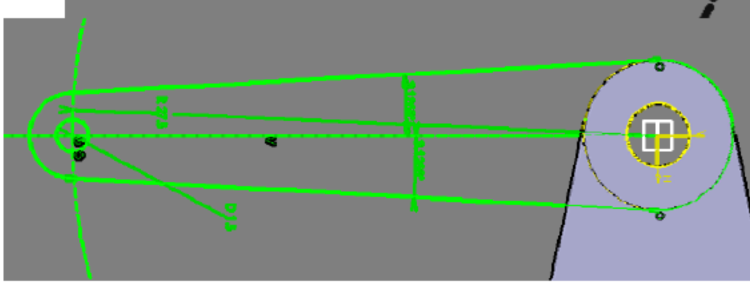


Figure 8: Represents the second sketch of the Center arm before being *padded.*

Later, another sketch was created on top of the 5cm extrusion; the process for making the circles was the same as in the first sketch. This was then *padded* to a length of 1cm (away from the sketch face).

2.3 – Knuckle Arm (Right)

2.3.1 3D Model

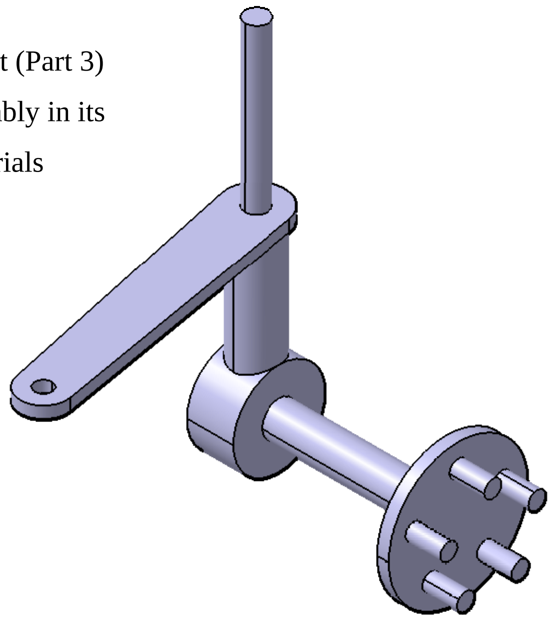


Figure 9: Knuckle Arm-Right (Part 3) of the Steering Wheel Assembly in its isometric view without materials applied (steel).

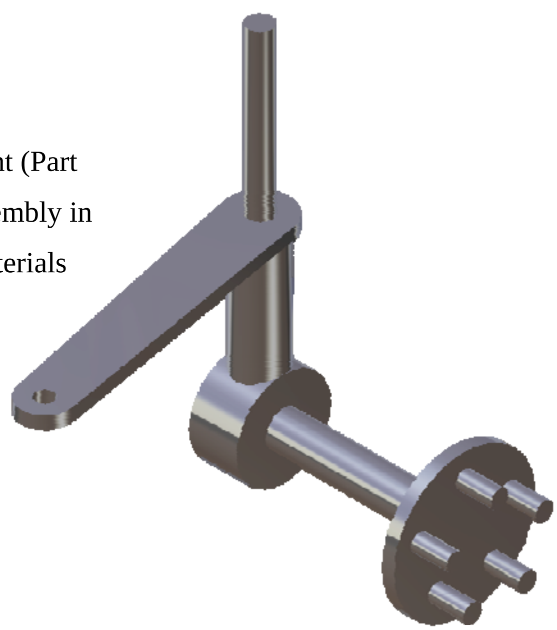
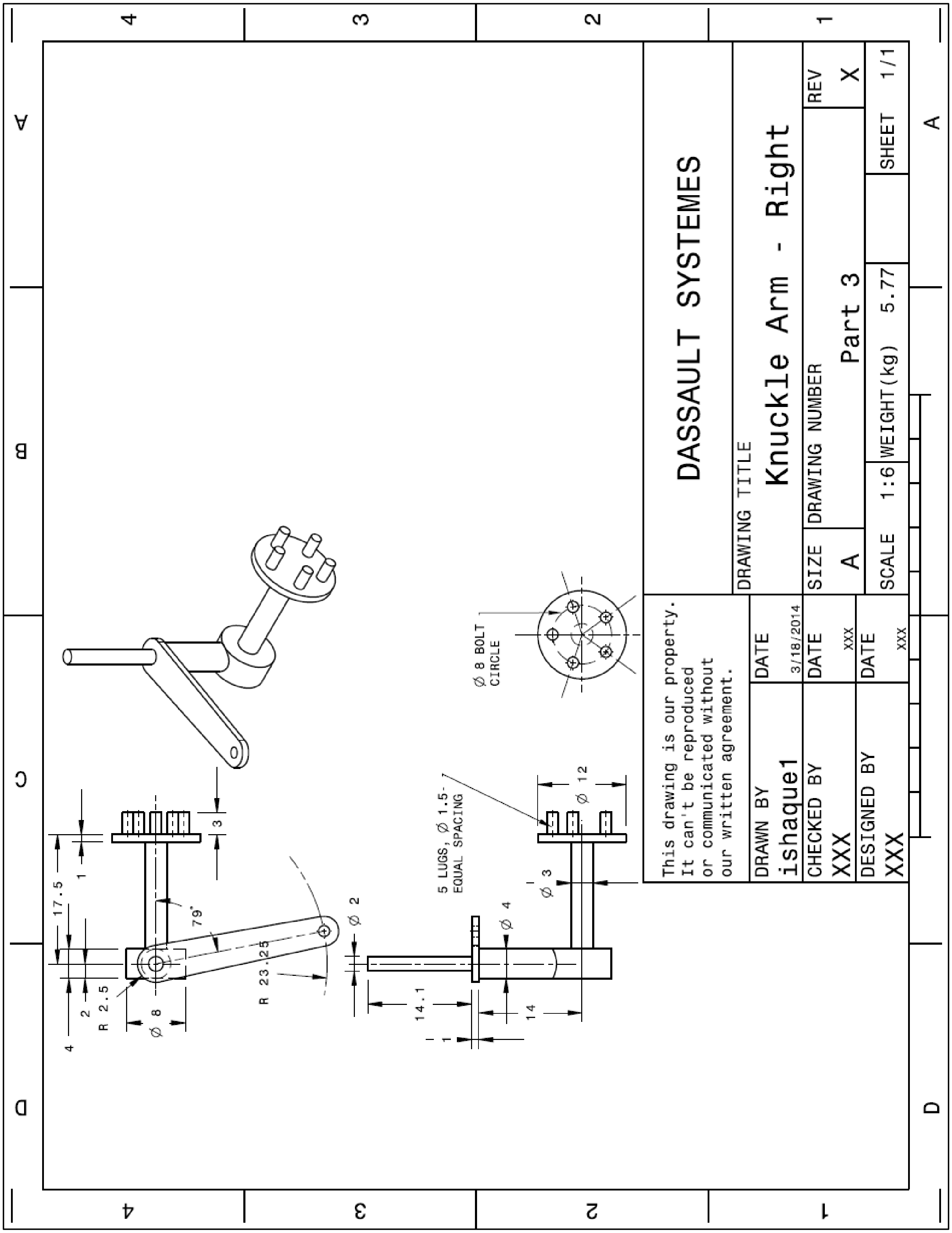


Figure 10: Knuckle Arm-Right (Part 3) of the Steering Wheel Assembly in its isometric view with its materials applied (steel).

2.3.2 Orthographic views



2.3.3 Other comments/calculations if applicable

This model was initiated by first creating the circular base from which the five extrusions came out from and was *padded* to a length of 1cm. The extrusions were centered around a circle with a diameter of 8cm. On this circle another circle with a diameter of 1.5cm was *constrained* to zero with the vertical axis and was padded to a length of 3 cm. Then, the *circle pattern* tool was used to create five equally spaced (72° apart) extrusions.

After all the extrusions were *padded* out, a link between the back of the extrusion base and the connector link was made from its center. A profile of a circle with a diameter of 3cm was *padded* to a length of 17.5cm. Then, from the end of this profile, another profile consisting of a circle with a diameter of 8cm was *padded* to a length of 2cm and was *mirror extended* on both sides.

Since the initial sketch started on the zx-plane, the xy-plane was used to create the first extrusion from the part as it lined perfectly with the horizontal. Once again, it was a circular profile with a diameter of 4 cm and was *padded* to a length of 14cm. From there another profile was made on top of this extrusion and several *construction elements* were used to create the proper geometry and generate the proper angle (79°). A circle was placed and centered with the *construction element* line and another *construction circle* (radius 23.25cm) with a diameter of 1.5cm. Another hole in the center of the original face extrusion was created with a diameter of 2cm. Then two other circles were created around the inner two holes (diameters 4 and 2cm respectively) and both were joined with the help of the *arc, bi-tangent line* and *trim* as shown in Figure 11.

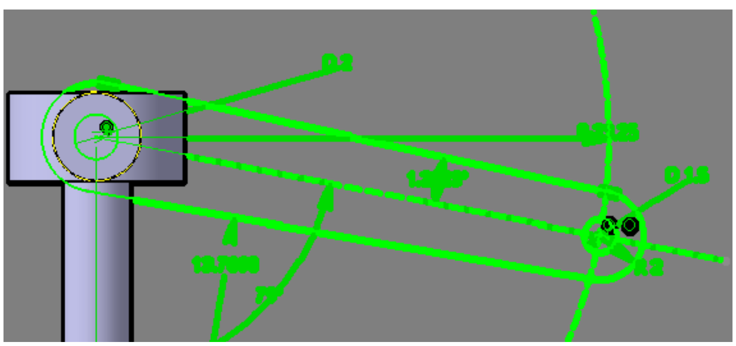


Figure 11: Represents the fourth sketch of the Knuckle Arm-Left

It was then *padded* to a length of 1 cm and a final pad within the left most inner circle was padded to a height of 15.1cm (taking into account the origin of the face) was created.

2.4 – Knuckle Arm (Left)

2.4.1 3D Model

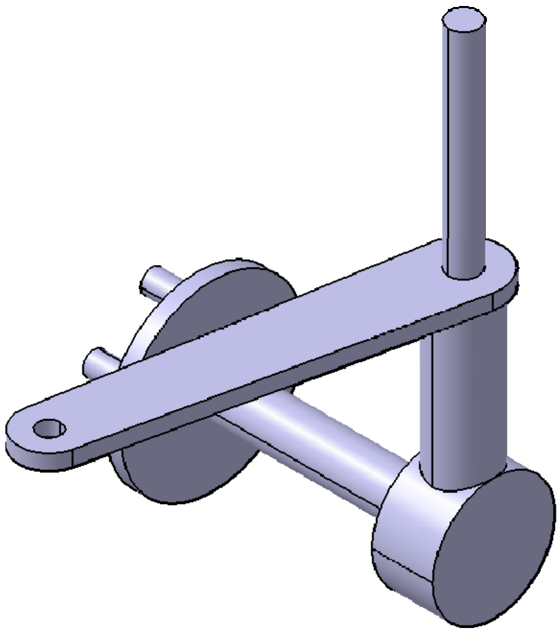


Figure 12: Knuckle Arm-Left (Part 4) of the Steering Wheel Assembly in its isometric view without materials applied (steel).

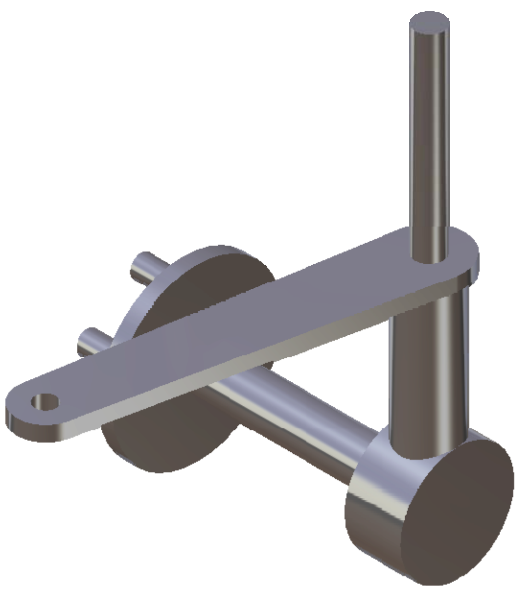
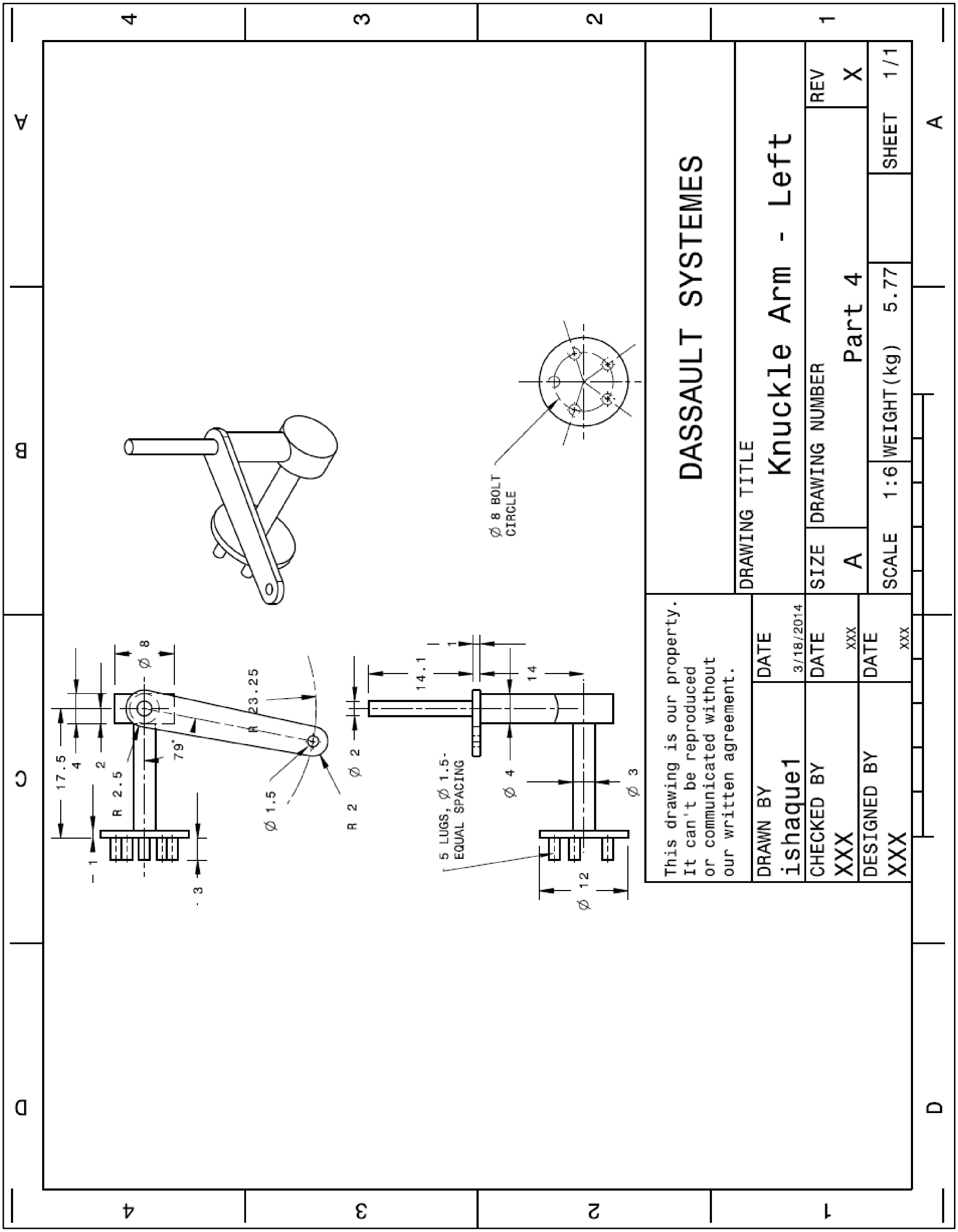


Figure 13: Knuckle Arm-Left (Part 4) of the Steering Wheel Assembly in its isometric view with its materials applied (steel).

2.4.2 Orthographic views



2.4.3 Other comments/calculations if applicable

This part is very similar to the Knuckle Arm-Right except that the origin beings on the same plane except in the negative directions. All the dimensions are similar except for their references.

2.5 – Tie Rod(s) (both)

2.5.1 3D Model

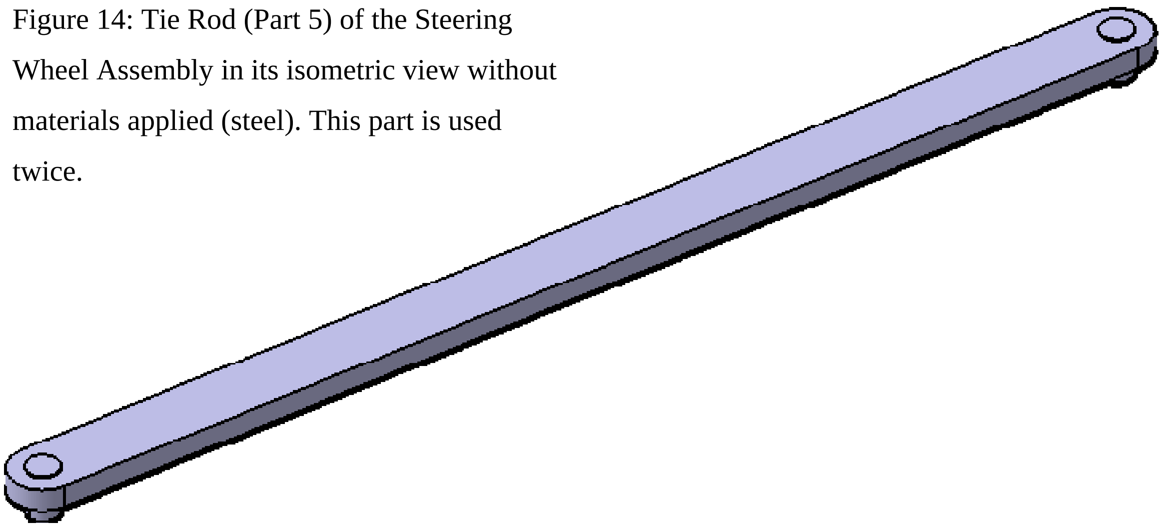


Figure 14: Tie Rod (Part 5) of the Steering Wheel Assembly in its isometric view without materials applied (steel). This part is used twice.

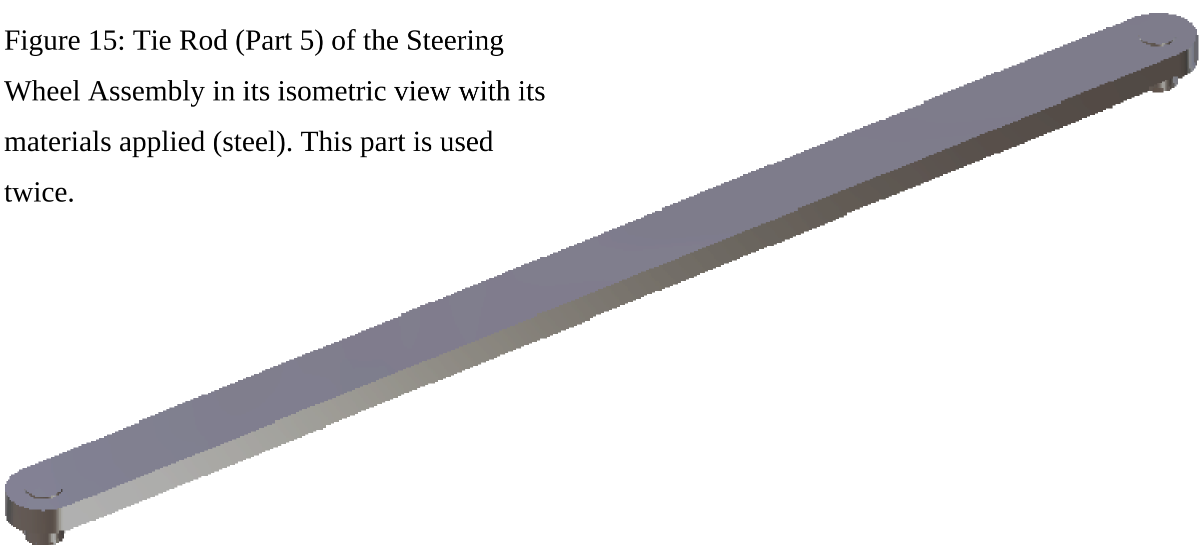
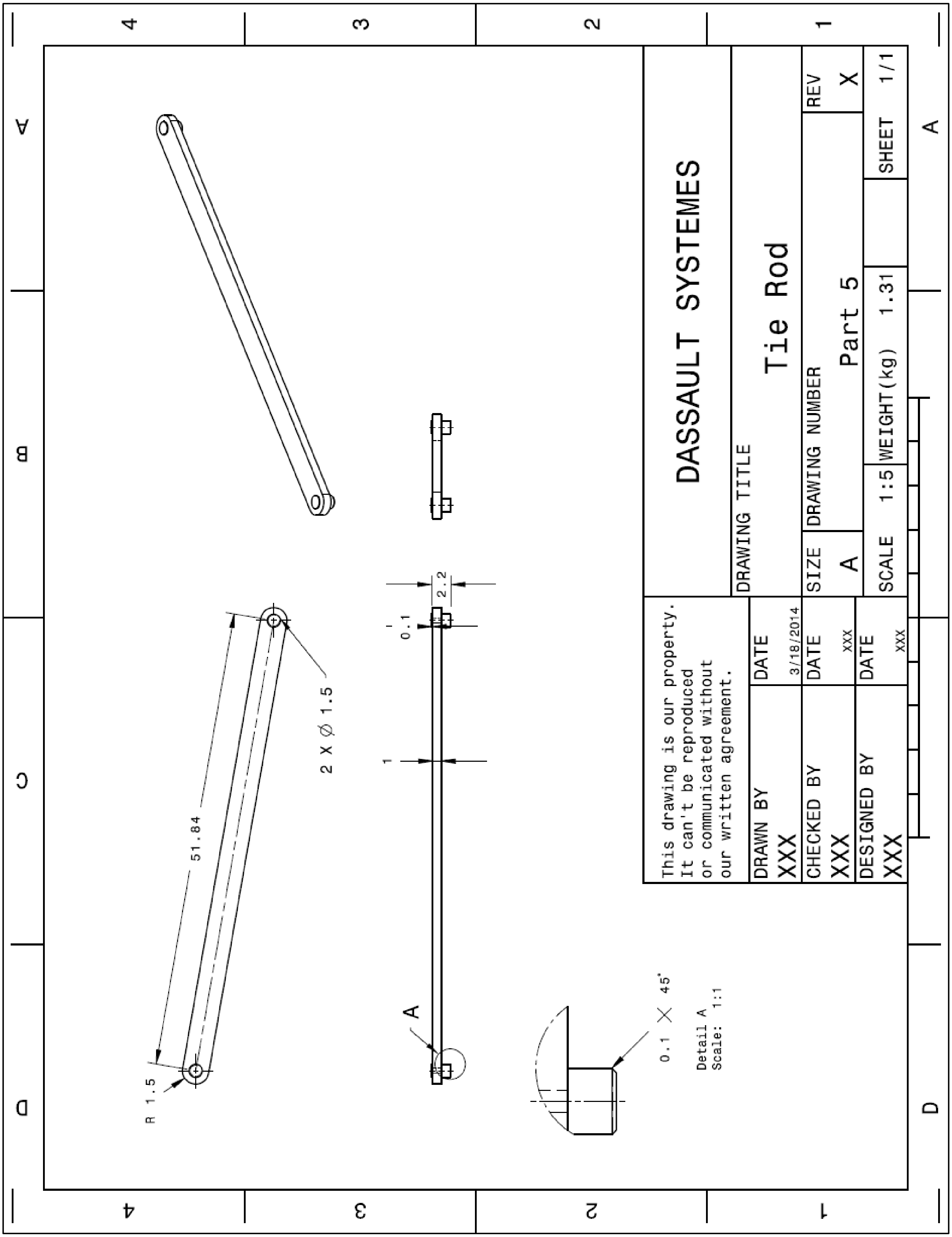


Figure 15: Tie Rod (Part 5) of the Steering Wheel Assembly in its isometric view with its materials applied (steel). This part is used twice.

2.5.2 Orthographic views



2.5.3 Other comments/calculations if applicable

Every part has its own trick and calculations associated with it. This part involved us to find the length of the Tie Rod itself. Not only was this possible in numerous ways but an idea was provided in the instructions manual. The first sketch, which started out in the xy-axis, had the highest *constructional elements* as compared to the other parts. The following is a representation of how our sketch appears to be:

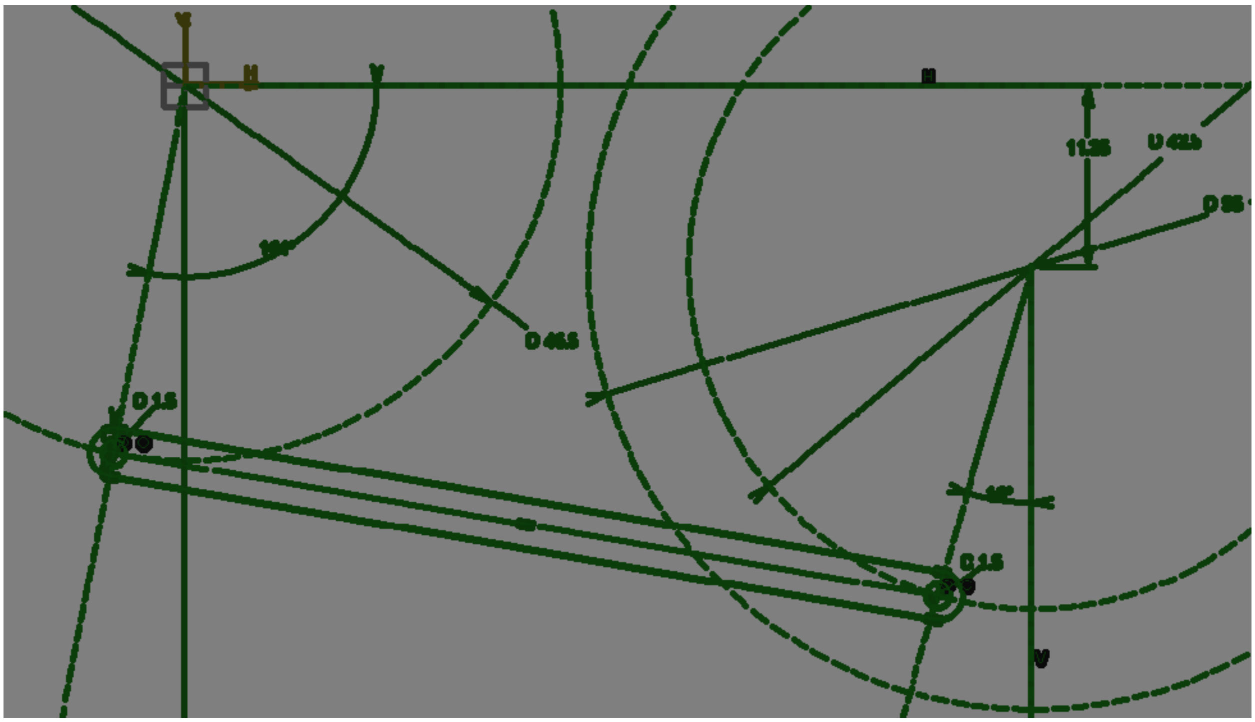


Figure 16: Shows the geometry associated with determining the length of the Tie Rod(s).

Once the length (51.84cm) was obtained, it was then a matter of what method seemed to be the easiest to model. As a group, it seemed ideal if we used the *elongated hole* tool and proceeded forward. The radius of this hole was 2cm. Two circles were added to each intersection with diameters of 1.5cm. It was then *multipadded* with the main thickness to be 1cm while the bolts extruded 0.1cm from the top and 2cm from the bottom. A *chamfer* tool was used on the most bottom two faces of the Tie rod with dimensions of 0.1cm x 45° to finalize the part.

2.6 – Wheel(s) (both)

2.6.1 3D Model

Figure 17: Wheel (Part 6) of the Steering Wheel Assembly in its isometric view without materials applied (steel). This part is used twice.

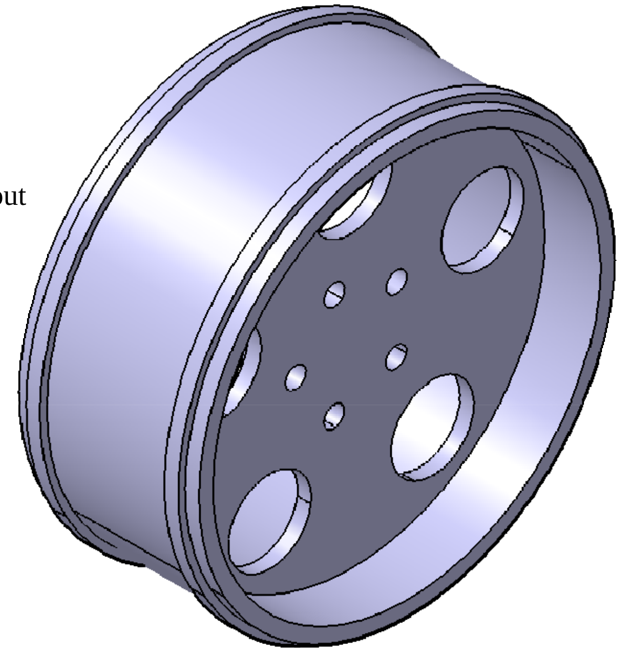
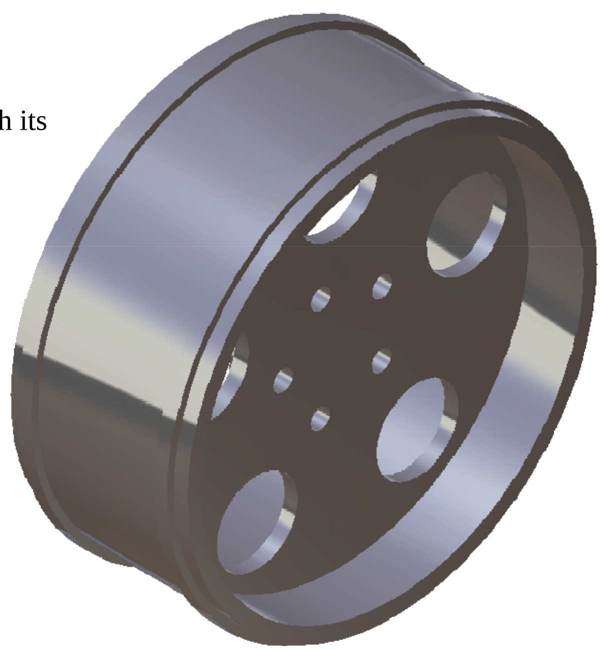
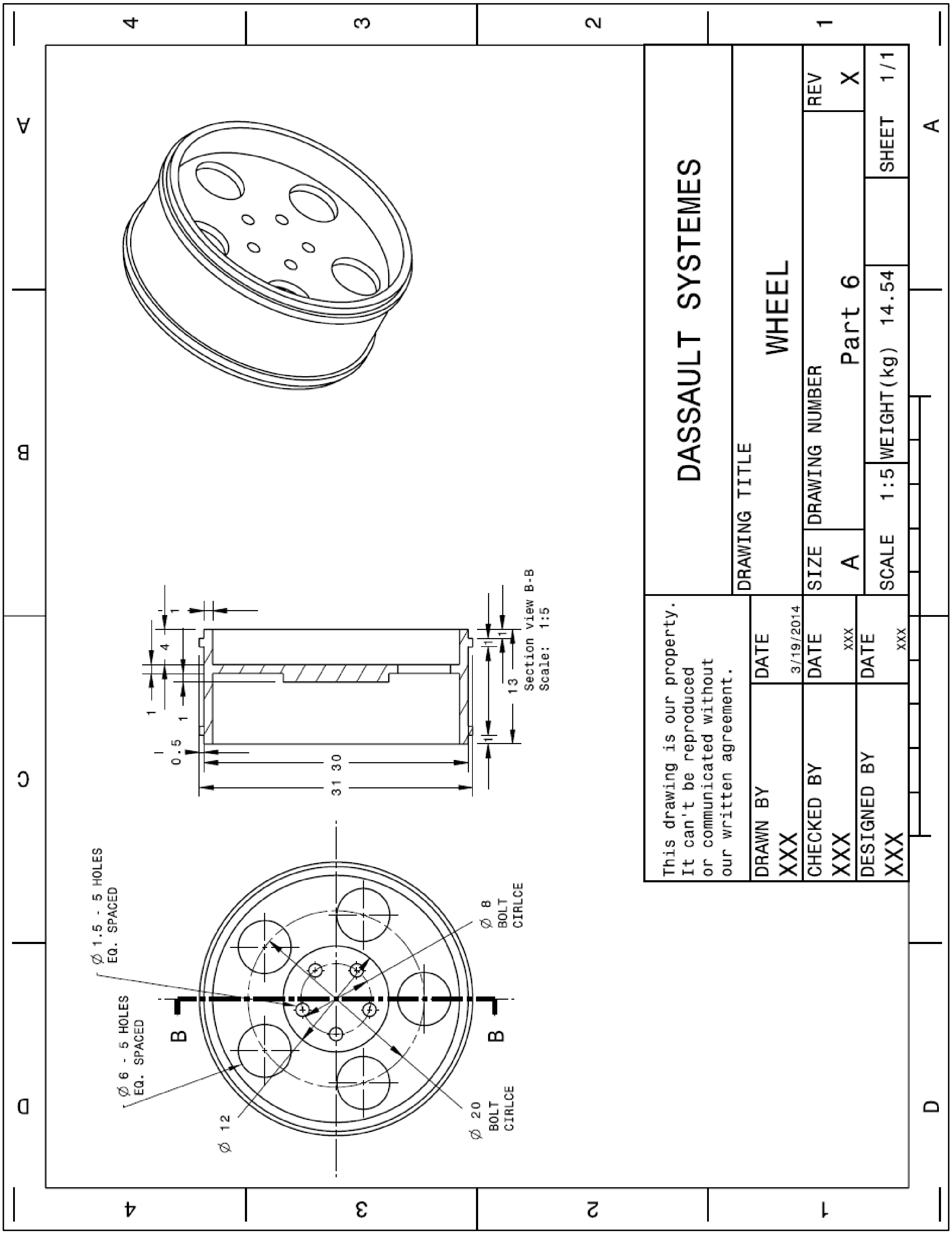


Figure 18: Wheel (Part 6) of the Steering Wheel Assembly in its isometric view with its materials applied (steel). This part is used twice.



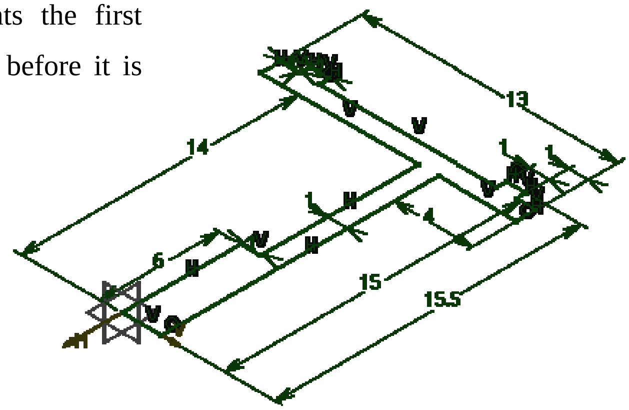
2.6.2 Orthographic views



2.6.3 Other comments/calculations if applicable

Amongst all the other parts, this was relatively one of the easiest to model. It only required one *shaft* and two *holes* which were then equally spaced to five (72° apart) with the help of the *circular pattern* tool. The sketch started on the xy-plane and was *shafted* to 360° around the y-axis.

Figure 19: Represents the first sketch of the Wheel before it is shafted.



Holes were created with the help of the *hole* tool and were constrained using *constructional circles* with diameters of 8 and 20cm respectively from the center. These smaller holes in the middle had the same diameter as the extrusions from the Knuckle arms, 1.5cm. The outer holes on the other hand had a diameter of 6cm.

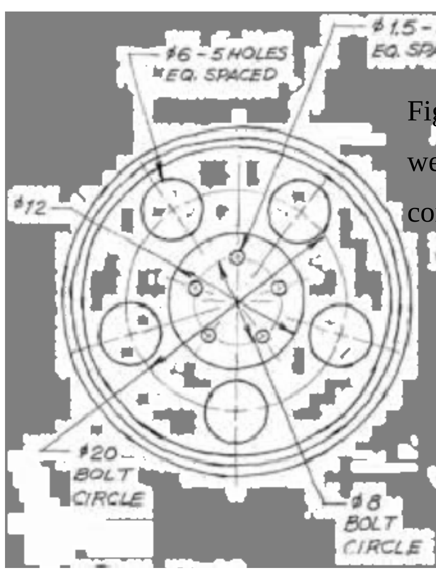


Figure 20: Illustrates what guidelines were followed when making the construction lines.

2.7 – Tire(s) (both)

2.7.1 3D Model

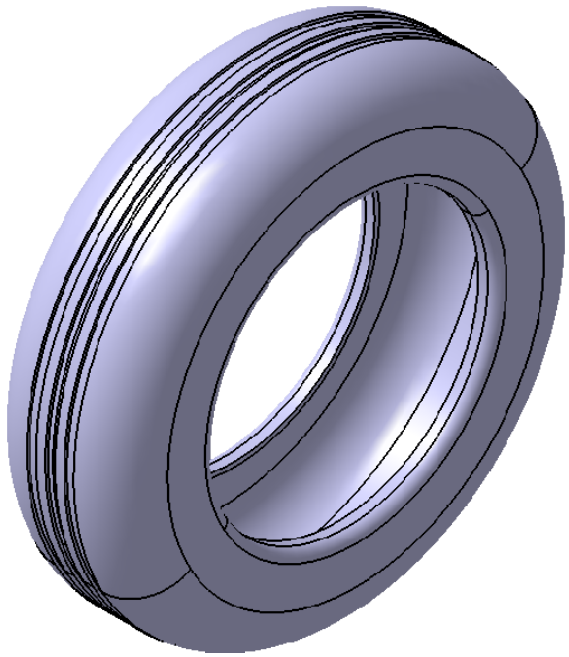
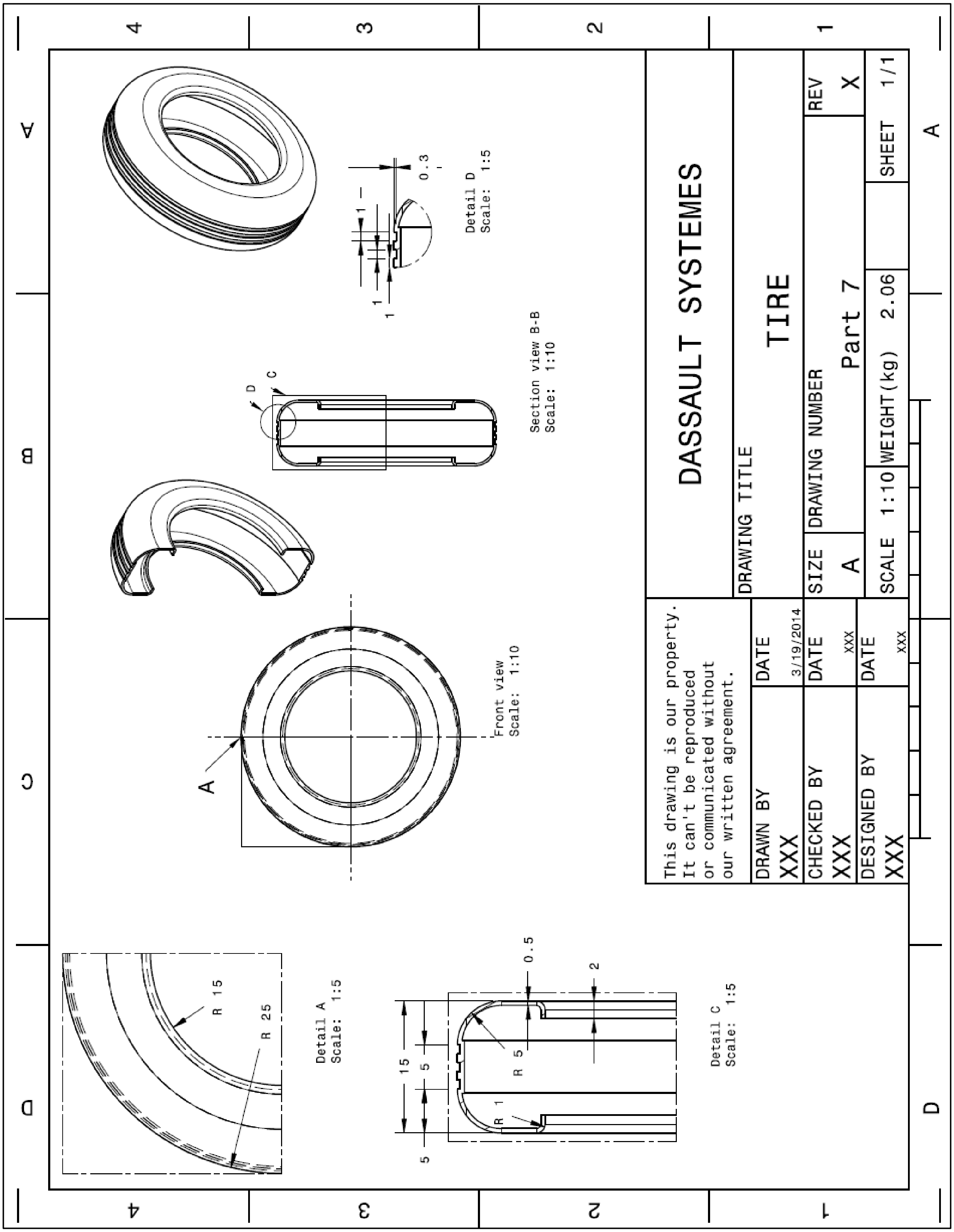


Figure 21: Wheel (Part 7) of the Steering Wheel Assembly in its isometric view without materials applied (steel). This part is used twice.

Figure 22: Wheel (Part 6) of the Steering Wheel Assembly in its isometric view with its materials applied (steel). This part is used twice.

2.7.2 Orthographic views



2.7.3 Other comments/calculations if applicable

Similar to the wheel, this part would be considered the easiest to model if it were not for the dimensions. Initially at a glance one can see that all it requires is a *shaft* but in fact it is not as easy as it looks. Toughness starts mainly when constraining everything to their proper dimension(s). Initially our approaches seemed to be all wrong as they involved one sketch that was partially constrained. It could never be perfect. After some time it was noticed that it was much easier to get the constraints for half of the sketch to work and as a result it was *mirrored* to bypass the previous errors.

The sketch started out on the xy-axis and was *shafted* along the y-axis to 360°. An *offset* of 0.5cm was created with the help of the offset tool to make it easier to sketch.

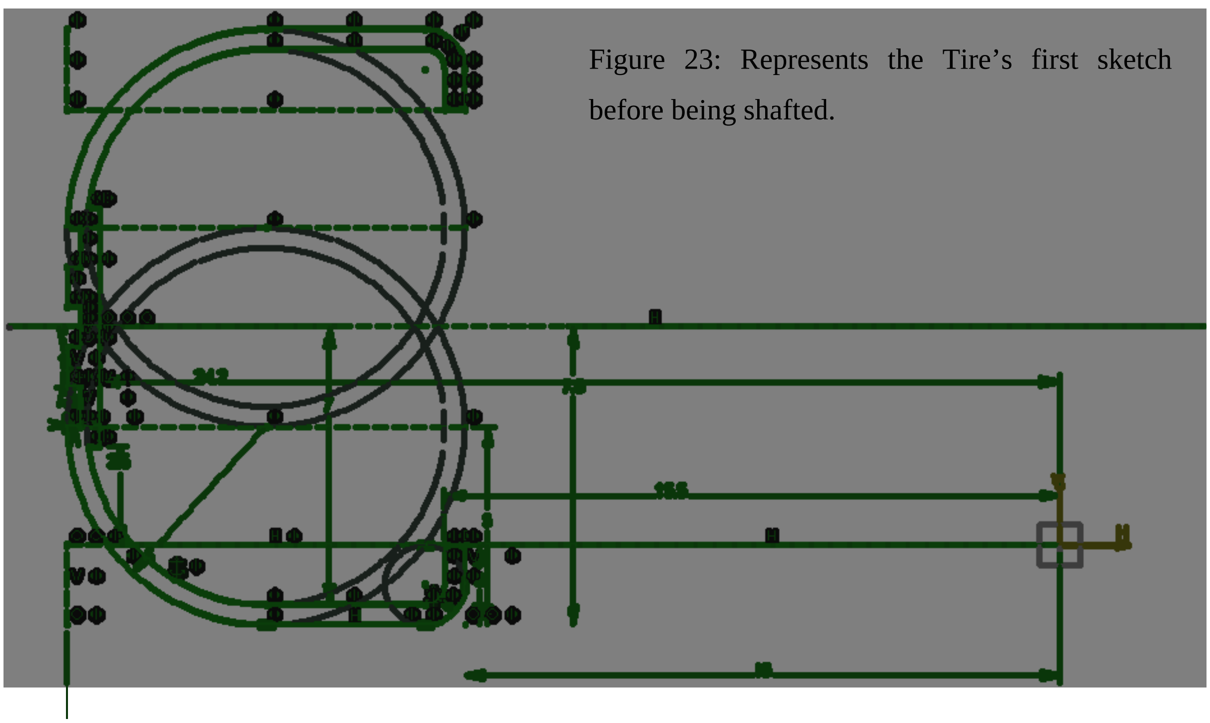


Figure 23: Represents the Tire’s first sketch before being shafted.

3 Assembly Design

In order to assemble parts together in CATIA V5R21, each part was copied into the assembly tree from its own. They were then linked together with the help of the *coincide* and *contact surface* tools. The following is a representation of how parts were linked together.

Represents parts being linked together with a contact surface and the green o represents axis being coincided. Copies of tie rod, wheel and tire were made and rotated accordingly to finish the assembly.

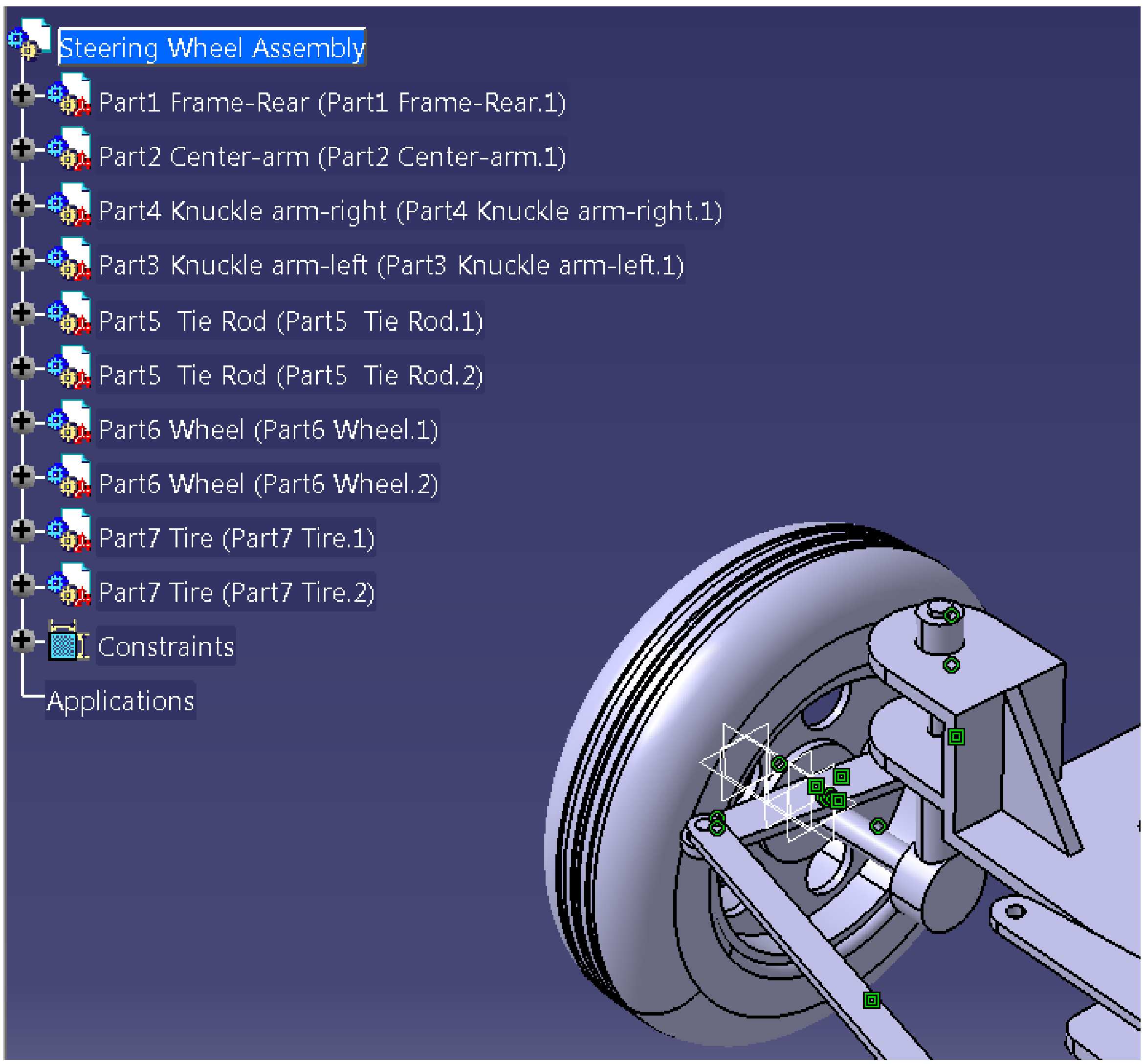


Figure 24: Represents the assembly of the rear steering linkage mechanism and displays the tree of which parts were added separately, in order.

3.1 *3D Model* of the Assembly

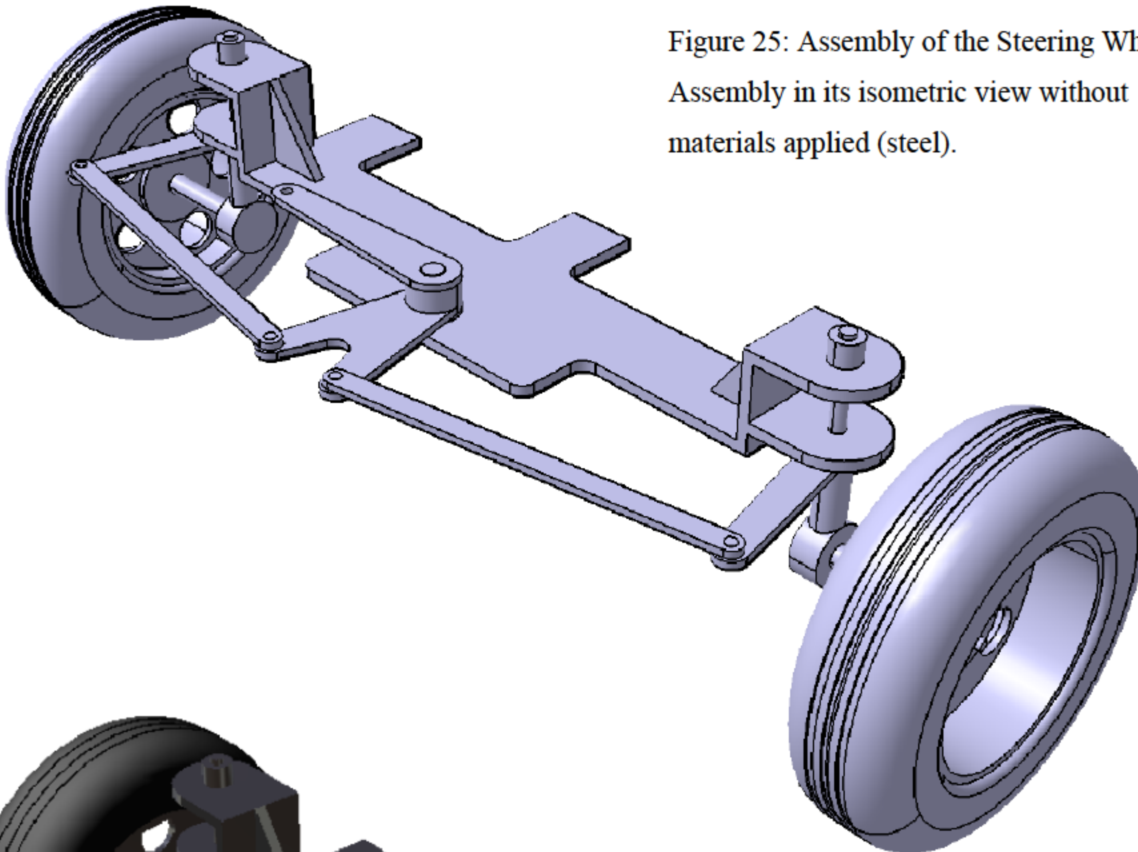


Figure 25: Assembly of the Steering Wheel Assembly in its isometric view without materials applied (steel).

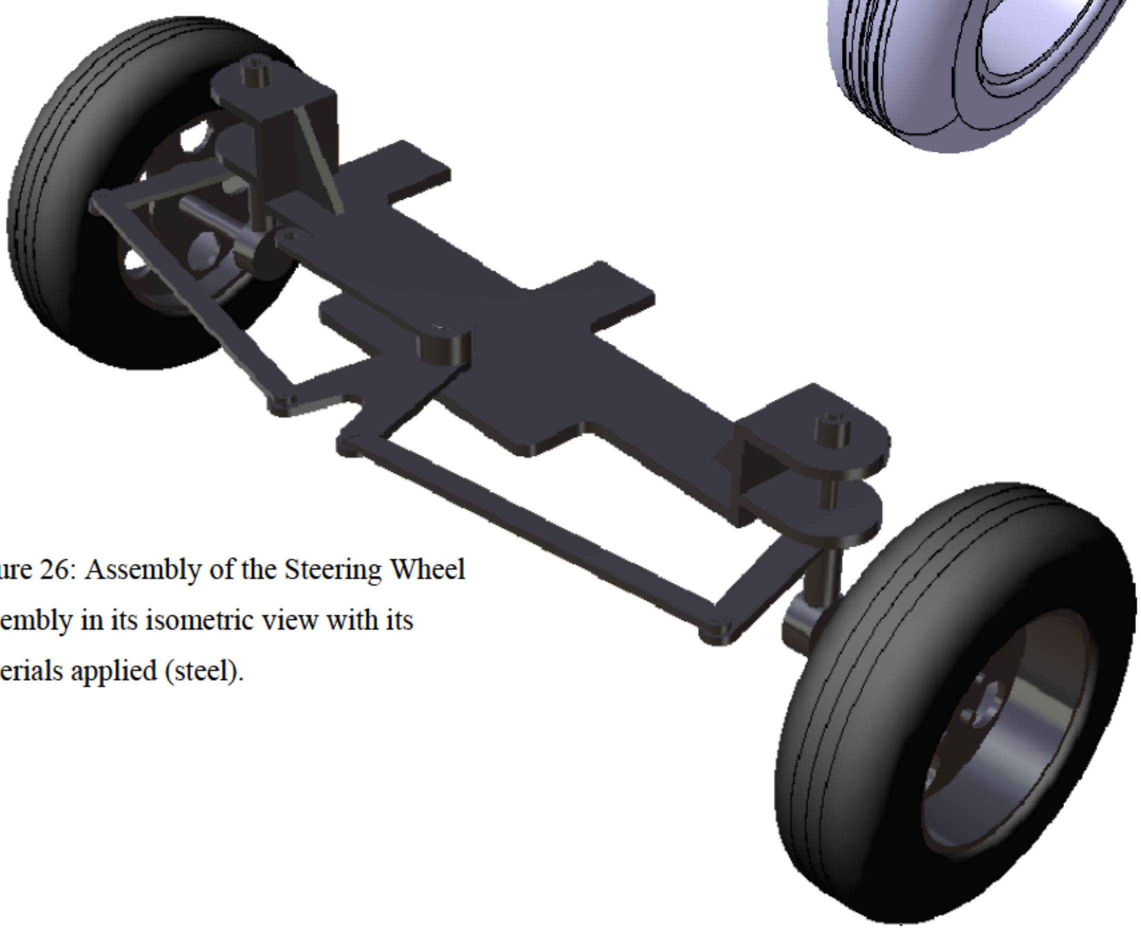
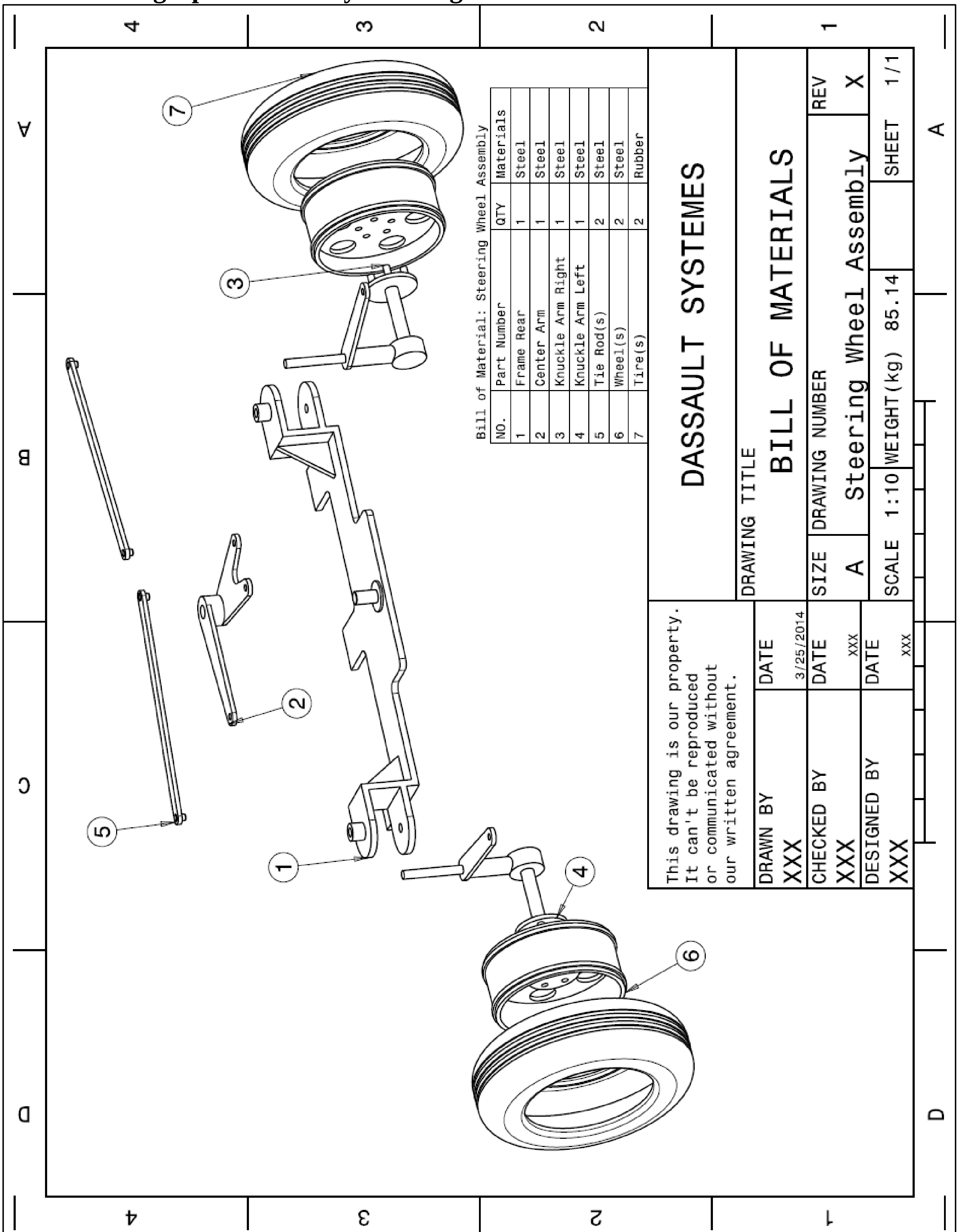


Figure 26: Assembly of the Steering Wheel Assembly in its isometric view with its materials applied (steel).

3.2 Orthographic Assembly Drawing



4 Conclusions

Every vehicle type is built independently from another. Of course the process for manufacturing may be the same but different factors such as weight and what type of body the car will have all play an important part. The logic behind all these has to make sense. If done incorrectly, the center of gravity can be totally changed and this may lead to several other problems.

With the information automatically generated on the drafting sheets, it was noted that the total weight for all parts together was 85.14kg (see 3.2). This seemed to be correct for an ideal car as the average weight was around 100kg. However, since this project is an illustration of the basic parts that may be involved in an actual steering wheel assembly, a lot of parts are missing. There are no indications of either inner or outer tire rods, the drive axle insert is missing and the tire is not well enough to be fit for the road.

There were also some ambiguous areas when the assembly system was linked together. The instruction manual used did not indicate if there had to be chamfers in the places such as the tie rod and frame rear. Assumptions had to be made and in each case, the thickness of the chamfer was 0.1cm and at an angle of 45°; as the tan of 45 is 1 (equally spaced). Dimensions were also cross linked between other teams who had the same part to model to avoid any partial error. Mistakes were corrected.

Finally, a material of steel was applied to every part but the tires, which were rubber. A final render was generated by using the scene tool as shown below:

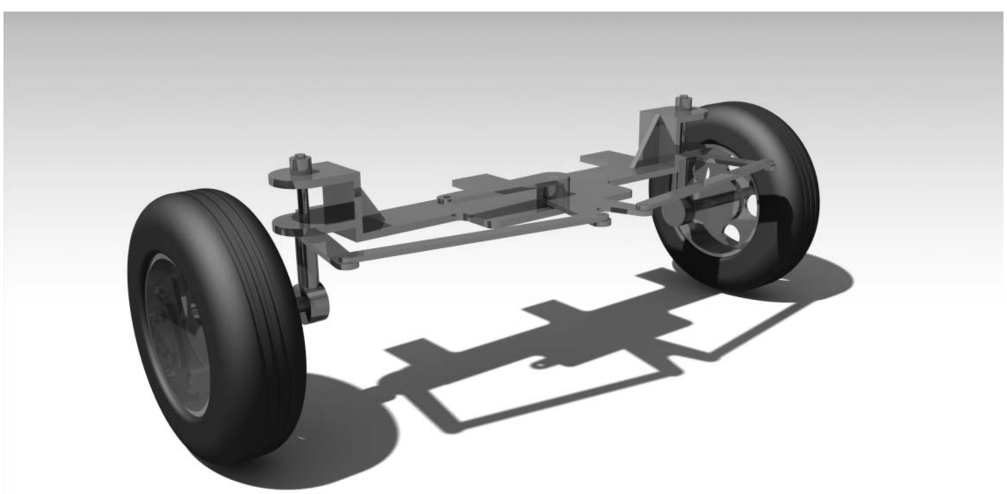


Figure 27: Represents the Rear Steering Linkage Mechanism fully rendered with its materials applied.

This project involved the incorporation of several tools learned throughout the course and tutorials. A total of twelve tools were used in the building of the rear steering linkage mechanism and although different methods could have been used, they were avoided due to clumsiness. The main purpose was to understand the properties and functions in CATIA V5R21 as they would aid in any projects we may have in the future. It was good to have an instruction manual which, although was not perfect, did help generously. As a result, any ambiguity made in the 3D models was indefinitely explained as a detail view in the respected orthographic views.

As engineers tasked to model this rear steering linkage mechanism, it is safe to assume that we will criticize something that does not make sense. It was quite obvious that this project was not intended for practical use but as an introductory to what the software program could achieve. We would have preferred to make something that was unique and could be used further down our career path. One man's *magic* is another man's engineering" [Robert A. Heinlein].

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4. "Training Report on Catia." *Scribd*. N.p., n.d. Web. 21 Mar. 2014. <http://www.scribd.com/doc/62766808/Training-Report-on-Catia>.

The references are:

1- Book
2- Website
3- Website
4- Report from a webpage