DESIGN AND FABRICATION OF DRIVER COMPARTMENT OF AN ELECTRIC GO KART

SYAZANA BINTI NOORSHIRWAN

Thesis submitted in fulfillment of the requirements
for the award of the Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

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SUPERVISOR DECLARATION

I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of the Diploma in Mechanical Engineering.

Signature :
Name of Supervisor : MOHAMAD ZAIRI B BAHAROM
Date :

STUDENT DECLARATION

I hereby declare that the work in this report entitled "*Design and fabrication of driver compartment of an electric go kart"* is the result of my own research except as cited in the references. The report has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

Signature :
Name : SYAZANA BINTI NOORSHIRWAN
ID Number : MB 10027
Date :

Specially dedicated to

My beloved family and those who have

Encourage and always be with me during hard times

And inspired me throughout my journey of learning

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ABSTRACT

The objective of this project is to design and fabricate driver compartment of an electric go kart. The main problem is the comfort of the drivers. The scopes identified must consist of cushioned seat and adjustable mechanism. The first stage is did some literature review about the existing go-kart and adjustable mechanism. Current model of go-kart consists of plastic and fixed seat. Hence, this project is to modify the current model of go-kart into a model that is comfort for the user where the driver compartment will be installed with an adjustable and cushioned seat. Follow up with some designing and sketching. During this phase, three designs had been sketch to be as the design concepts. As for each design have their advantages and disadvantages. After done with design and sketch, conceptual process is done and design 3 has been chosen because this design is more advantageous than other two designs. Design 3 is small and the adjustable mechanism is easier to handle. Some modification is done on design 3 where, seat mounting is being added for placing the cushioned seat. Next stage after finalize the design, the project is continued with fabrication process. The adjustable is modified into smaller width according to the design dimension where, both side of the adjustable mechanism is connected with a small angle bar in the middle by welding. While for the seat mounting, a square hollow beam is used. The hollow beam is measured and marked with the correct length and then being cut into the desired length. Drilling is done on the hollow beam for assemble the seat on the seat mount. After that, the square hollow beam is welded on the adjustable mechanism according to the drawing. Finish with the welding, finishing process is done where for this project white paint is used and then the cushioned is assembled with the product. Thus, by finishing this project, the objective of the project is achieved

ABSTRAK

Projek ini bertujuan untuk mereka dan menghasilkan ruang pemandu bagi go-kart elektrik. Masalah utama yang dihadapi adalah keselesaan pemandu ketika memandu. Projek ini perlu merangkumi skop-skop berikut, mempunyai tempat duduk berkusyen dan mempunyai mekanism boleh laras bagi menggerakkan kedudukan tempat duduk ke depan dan kebelakang. Langkah pertama yang dilakukan adalah malakukan sedikit kajian mengenai model go-kart yang sedia ada dan mengenai mekanism boleh laras. Model sedia ada mempunyai tempat duduk plastic dan kedudukan yang tetap. Oleh itu, projek ini bertujuan untuk mengubahsuaikan model sedia ada menjadi model yang selesa untuk pemandu di mana bahagian pemandu akan dipasang dengan tempat duduk berkusyen and boleh dilaras. Seterusnya, fasa mereka dan melakar di mana tiga rekaan dilakar untuk dijadikan sebagai konsep reka bentuk. Setiap rekaan mempunyai kelebihan dan kekurangan masing-masing. Selesai dengan fasa mereka dan melakar, proses pemilihan konsep dilakukan dan reka bentuk 3 dipilih berdasarkan kelebihan rekaan ini iaitu rekaan ini lebih kecil dan mekanism pelarasannya lebih mudah digunakan berbanding dengan dua reka bentuk lain. Sedikit pengubahsuaian dilakukan ke atas rekaan 3 bagi memudahkan pemasangan tempat duduk akhir nanti. Selepas memilih konsep rekaan yang terbaik, fasa pembuatan dijalankan. Mekanism pelarasan diubahsuai mengikut lebar dimensi lukisan dan disambung oleh ‘angle bar’ bersaiz kecil melalui proses kimpalan. Bagi tempat pelekap kerusi, ‘square hollow beam’ digunakan. Bahan tersebut diukur dan ditanda mengikut ukuran yang dikehendaki dan kemudiannya dipotong mengikut ukuran yang ditanda. Proses penggerudian dilakukan ke atas ‘square hollow beam’ untuk pemasangan tempat duduk kemudian. Selepas itu, bahan yang sudah digerudi itu dikimpal di atas mekanism pelarasan mengikut lukisan yang telah dilukis. Akhir sekali, produk yg sudah disiapkan di cat menggunakan cat putih sebagai kemasan sebelum tempat duduk dipasang. Dengan menyiapkan projek ini, objektif projek in tercapai.

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LIST OF ABBREVIATIONS

PPE	Personal Protective Equipment
SMAW	Shielded metal arc welding
UMP	University Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter will explains about the project background, project objective, project scope and the project flow that has been conducted throughout the semester. Besides that, in this chapter also consist of flow chart and Gantt chart of the project which explains the overall procedures and the times being distributed to finish this project.

1.2 PROJECT BACKGROUND

Art Ingels developed the first go-kart in 1956 in Los Angeles, California. Ingels was a race car builder for Kurtis Kraft, a race car designer and developer. In 1958, Go Kart Manufacturing Co. Inc. became the first company to manufacture and to distribute go-karts. In 1959, McCullough was the first company to manufacture go-kart engines. In 1957, the International Kart Federation or IFK, began establishing the rules for go-kart competitions. By 1960, go-kart racing began to appear at local tracks across the United States. Throughout the decade, new go-kart tracks surfaced in many different cities and states. Go-karts continued to evolve thanks to the innovation of builders and designers. Go-karts originally were simple and straight forward machines. Over the course of the last five decades, they emerged as machines involving sophisticated and advanced assembling. Despite the advancement in styles, go-kart racing remains the least expensive form of professional auto racing. While go-karts originated from United States, interest in go-kart racing began to pique in other countries and continents throughout the worlds, most notably Europe and Australia. For example, in 1966, the

Australian Karting Association or AKA, was formed to promote go-kart racing in Australia. The Motor Sports Association or MSA, became the governing body for go-kart racing in United Kingdom in 2000s. in 1971, the World Karting Association or WKA, was formed as a non-profit company supporting the developing sport of go-kart racing. The organization rapidly progressed to become the largest go-kart racing sanctioning body in the United States, with more than 10,000 participants.

Racing go-karts have evolved over the past 50 years to become one of the most competitive forms of motor racing in the United States. Kart racing has been a "stepping stone" for many drivers working their way up the professional ladder in NASCAR, Formula 1, and the Indy Racing League. Drivers like Tony Steward, Danica Patrick, Michael Schumacher and Sarah Fisher each got his or her start in this less expensive but adrenaline pumping form of motorsports racing. As a recreational activity, karting can appeal to just about anyone. From age 5 to 75, racing go-karts have become popular all over the world with people looking for an exciting way of having fun. In fact, many amusement parks have added rental racing go-kart (called concession karts) that use detuned 4-stroke go-kart engines for a milder experience.

1.3 PROBLEM STATEMENT

The problem statements of this project are:

i) To improve the skills and knowledge of Mechanical Engineering students in designing and importance of project developing go-kart
ii) The comfort of the go-kart users

1.4 OBJECTIVES OF THE PROJECT

The objectives of this project are:

i) To design the driver's compartment in a go-kart
ii) To fabricate the driver's compartment in a go kart

1.5 SCOPES OF THE PROJECT

This project will be limited within the following aspects which are:

i) A conceptual design by using solid works
ii) A seat with an adjustable mechanism
iii) A cushioned seat for the go-kart
iv) The floor dimension on the chassis is 400mm x300mm

1.6 PROJECT PLANNING

Figure 1.1 shows the flow chart of the whole Final Year Project. This project started with meeting the supervisor to discuss about problem statement, objective and scopes the project title given and managed the schedule of weekly meeting. The meeting was set up on every Wednesday. Then followed with made some research about the project and literature review where it took about seven weeks to be done.

Then followed with sketch and design phase where few sketches need to be done as the design concepts. Each design concepts then need to be analyzed t and chose as the final design. When final design is chose, propose the design to the supervisor. After the approval of the supervisor, the design is converted to the 3D drawing using Solid Works software.

Finished with all the sketches and design phase, the preparation of mid-presentation was next. This task took about a week to be done. Few days before presenting, the slides presentation will be presented to the supervisor for some comments and corrections to improve the slides. With the knowledge attained and instilled in the design phase, the first half progress of the project was presented to the three panels of judges.

After mid-presentation phase, some survey is done for the materials needed for the project. There were only few materials needed in order to fabricate the adjustable

mechanism and to find the cushioned seat. Other needed materials were well-prepared by the university.

Fabrications phase started with the basic fabrication process like measuring, cutting and the joining process. For this project joining processes involved were welding and fastening.

The last task will be the final presentation and report writing that need to be accomplished before the semester break. The final presentation then again will be presented in front of the assigned panels. A draft report was submitted to the supervisor to be point out the flaws. Corrections were done and the final report was handed as the completion of the Final Year Project.

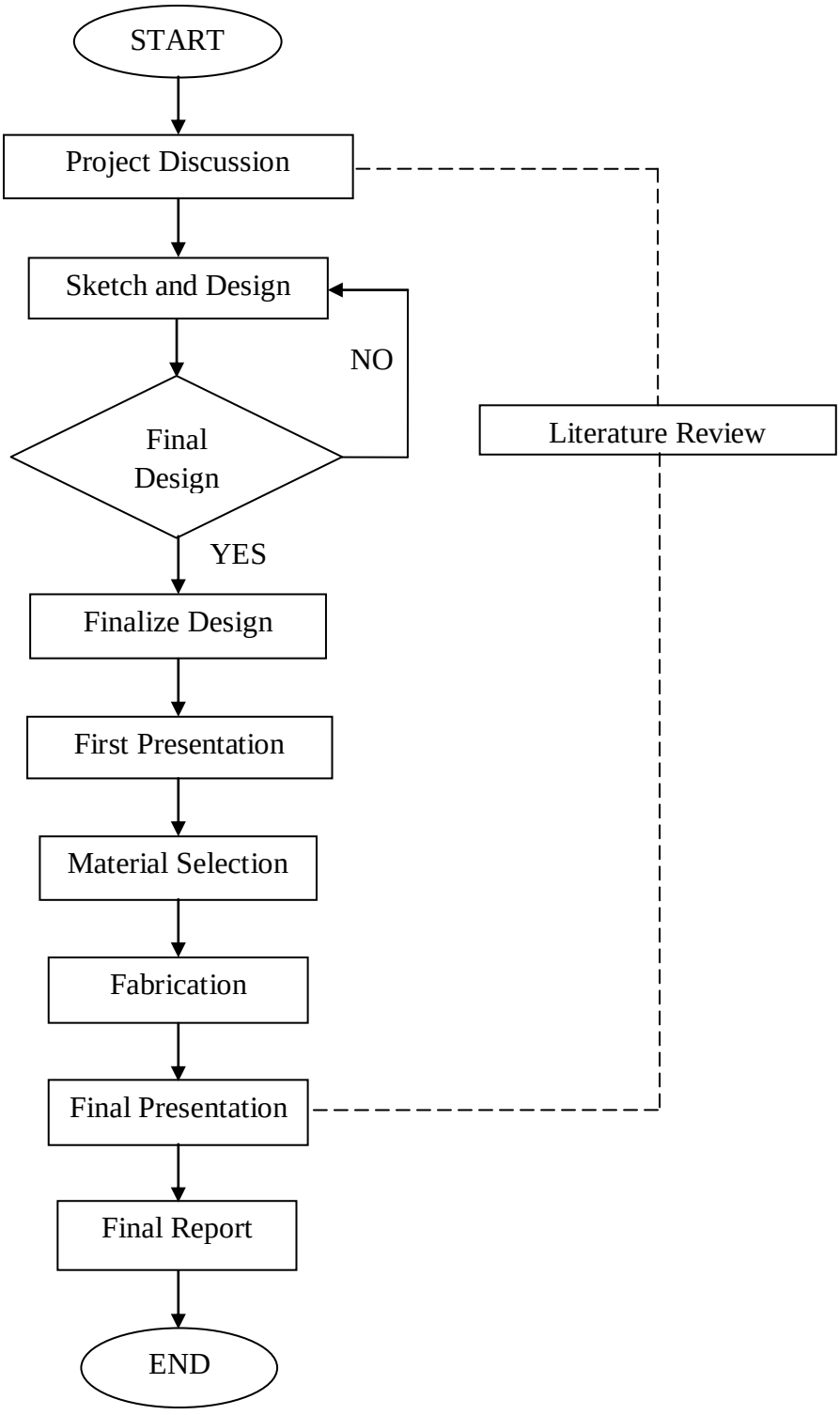

Figure 1.1: Project flow chart

Table 1.2: project Gantt chart

WEEK ACTIVITIES		1	2	3	4	5	6	7	8	9	10	11	12	13	14
PROJECT DISCUSSION	PLAN														
	ACTUAL														
MEETING WITH SUPERVISOR	PLAN														
	ACTUAL														
SKETCH AND DESIGN	PLAN														
	ACTUAL														
FINALIZE DESIGN	PLAN														
	ACTUAL														
FIRST PRESENTATION SLIDE	PLAN														
	ACTUAL														
FIRST PRESENTATION	PLAN														
	ACTUAL														
FABRICATION	PLAN														
	ACTUAL														
FINAL PRESENTATION SLIDE	PLAN														
	ACTUAL														
FINAL PRESENTATION	PLAN														
	ACTUAL														
FINAL REPORT	PLAN														
	ACTUAL														

By referring the Gantt chart in table 1.2, this final year project start with some introduction or briefing discussing about the objective, scope and identify the problem for the project. Then, started do some research and literature review from the internet and some reading that related to this project. All of this literature review took about nine weeks to be done.

While doing the research, sketching design concepts is needed. However, the actual duration for the concept design is longer than the planning duration due to some difficulties to decide the concept designs. The sketch and design took about three weeks to finish. Finalize design done on the next week.

The duration for the fabrication process also is longer than the planning schedule due to lack of tools facilities in the workshop. Since the numbers of the instrument and tools are few thus, in order to finish the project need to take turn to use the facilities. Other than that, machine problems also one of the factors the time for fabrication was extended.

Lastly, after finish with fabrication and presentation, the report writing needed to be submitted. This task took about a week to be done. The report was done based on UMP thesis format and also guidance from the supervisor. all tasks scheduled took about fourteen week to finish

1.7 THESIS OUTLINE

In Chapter 1, it would explain about problem identifications, objectives, scopes, flow charts and Gantt chart of the project. In this chapter also contain the planned direction of the Final Year Project.

In Chapter 2, it will go through the literature review of the go-kart driver's compartment. This chapter will discuss about the existing model of go-kart's driving compartment and the adjustable mechanism of the car that will be installed later in the go-kart.

In Chapter 3, it will explain about the design concepts and the selection of the final design of the project. This chapter will discuss more about the concept that has been sketched out and the selection done to fabricate the go-kart driving compartment.

In Chapter 4, would go through the fabrication process of the selected design, the tools, and the machines used for fabricating will be discussed.

In Chapter 5, will be focus about detail on the final product that had been fabricated. There will be explanation about the fabricated product and will be shown in this chapter. The result and discussion also will be included in this chapter.

In Chapter 6, will be containing the conclusion of the project. Also some recommendation will be included in this chapter for improving the product.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discuss about the literature review about the current go-kart design. In this chapter, the explaination will be focused on the go-kart driver compartment instead of the whole go-kart. This chapter also will be included the basic explaination about the seat track mechanism (adjustable).

2.2 CURRENT DESIGN OF GO-KART

Go-kart is a small car that use for recreational and competition purpose hence the design need to be convinience and user-friendly for all drivers. After done some research, there are lots of go-kart design in the market. However, some or can be said that all of the go-kart design using plastic seat and the seat is fixed. Figure 2.1, Figure 2.2 and Figure 2.3 shows different designs but with same inner part.

Figure 2.1 first current design

Source: http://chfourstar.en.made-in-china.com

Figure 2.2 second current design

Source: http://www.ceet.niu.edu

Figure 2.3 third current design

Source: http://www.lulusoso.com

These current designs are convenience for certain group of people since the seats maybe not so comfortable for all people.

2.3 ADJUSTABLE MECHANISM

A seat track mechanism for vehicle seat, comprises a pair of substantially parallel movable rails attached to the vehicle seat, a pair of substantially parallel stationary rails attached to the floor section of a vehicle. The movable rails being combined with the stationary rails so as to be slideable along the stationary rails and the shutter members for covering the stationary rails. The shutter members being movably supported to the stationary rails and then under bottom portions of the stationary rails, the shutter members having openings and the movable rails being combined with the stationary rails through the openings of the shutter members. Figure 2.4 shows the drawing of the seat track.

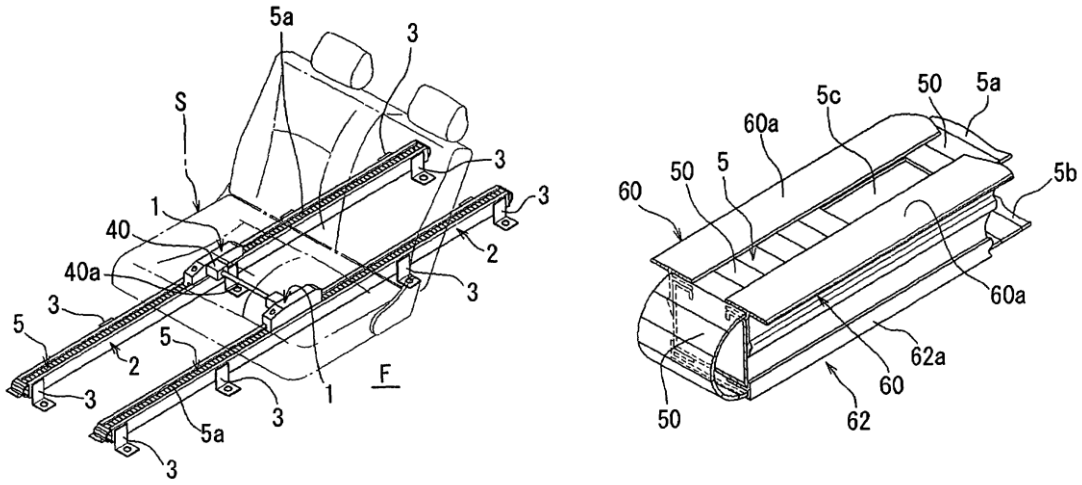

Figure 2.4 the image of the seat track

Source: http://www.skidmore.edu

Figure 2.5 seat track mechanism

Source: http://www.bremarauto.com

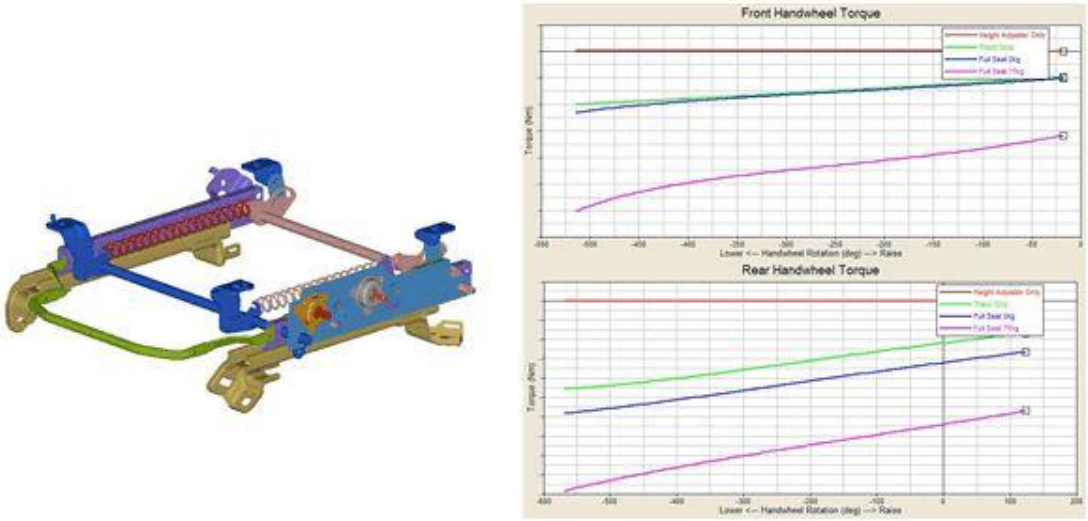

Figure 2.6 Simulation on the seat track

Source: http://www.bremarauto.com

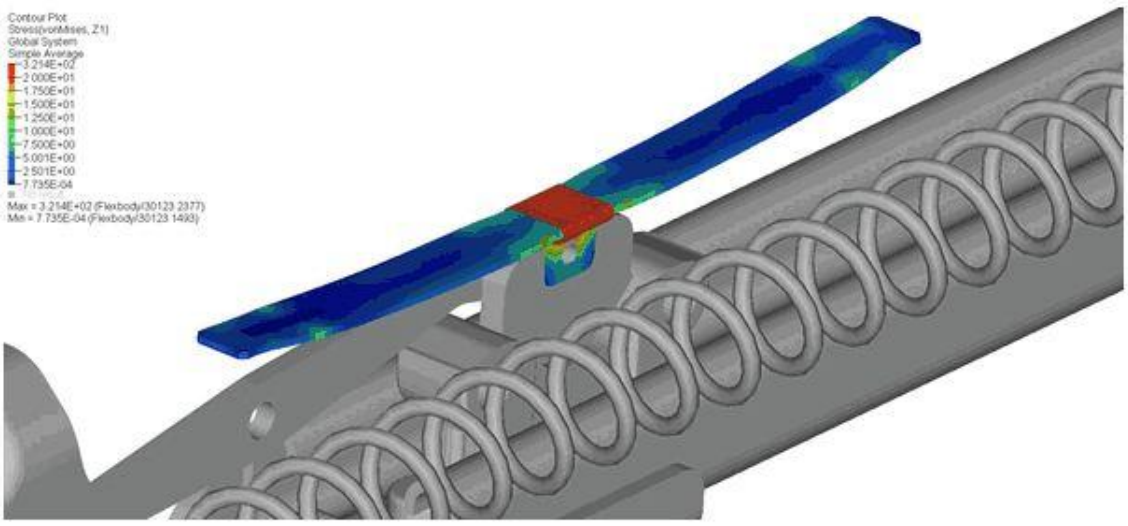

Figure 2.7 Simulation on part of the seat track

Source: http://www.bremarauto.com

Figure 2.5 shows the mechanism of the seat track. While Figure 2.6 and Figure 2.7 shows the adjustment mechanism of an automotive seat was simulated to calculate various parameters such as torque required at the height adjustment handwheels for different occupant loads, and the range of motion of the occupant's hip joint. The analysis was also used to determine loads between various components and to calculate stresses in the leaf return spring. MBD was the ideal tool of choice for this stress

analysis, as it provide accurate input loads without having to make any simplifying assumptions to represent the loading.

CHAPTER 3

PROJECT METHODOLOGY

3.1 INTRODUCTION

In this chapter will explain three design concepts for the driver compartment of the go-kart based on the scopes stated earlier. In this chapter also will discuss about the advantages and disadvantages of the design concepts and explanation in order to select the best design concept from the three designs to be fabricated. It also included the three designs comparison using selection criteria that are considered the best for the go-kart.

3.2 DESIGN

As for this project, the driver compartment is focused on the sitting part of the go-kart hence the design will lead to the design of the adjustable mechanism. Therefore, the aspect that must be considered in designing is the operating mechanism, weight and ease of design. Finally, the design of the system should be easy to fabricate and assemble in accordance with the drawing.

3.2.1 Design 1

Figure 3.1 shows the isometric view of design 1. The advantages of this design are stable and adjustable. The disadvantages are bulky, the adjustable mechanism is hard to use, there are many small parts and no seat mount.

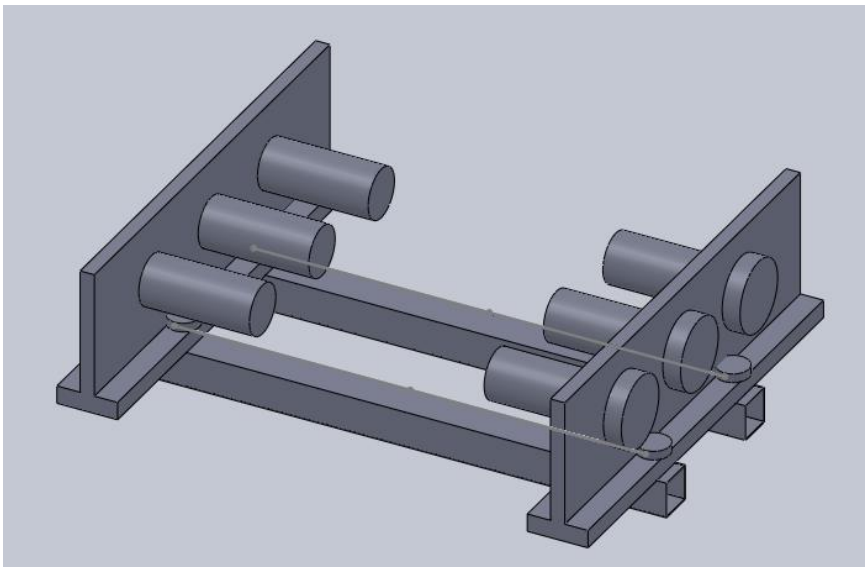

Figure 3.1 design 1

3.2.2 Design 2

Figure 3.2 shows the isometric view of design 2. For this design, the advantage is adjustable and has a mount to assemble with the seat. The disadvantages are the adjustable mechanism is hard to use and has many small parts.

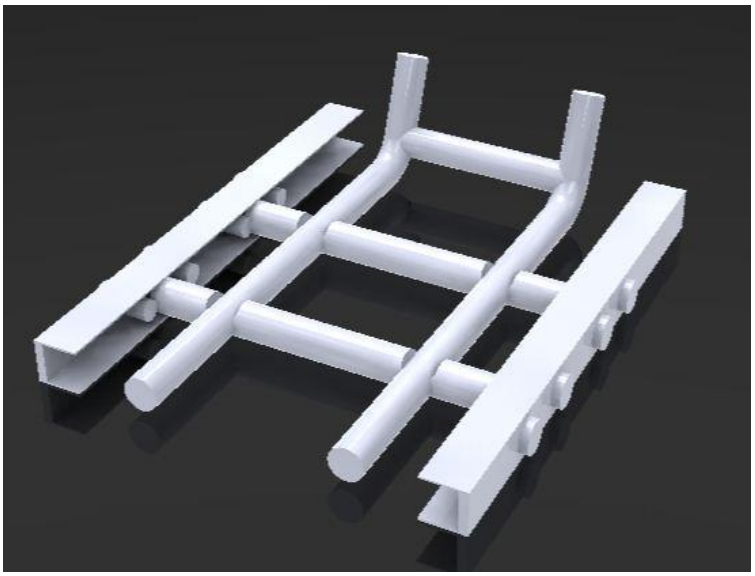

Figure 3.2 design 2

3.2.3 Design 3

Figure 3.3 shows the isometric view of design 3. Advantages of design 3 are adjustable, small and the adjustable mechanism is easy to operate. However, the disadvantage for this design is has no seat mount.

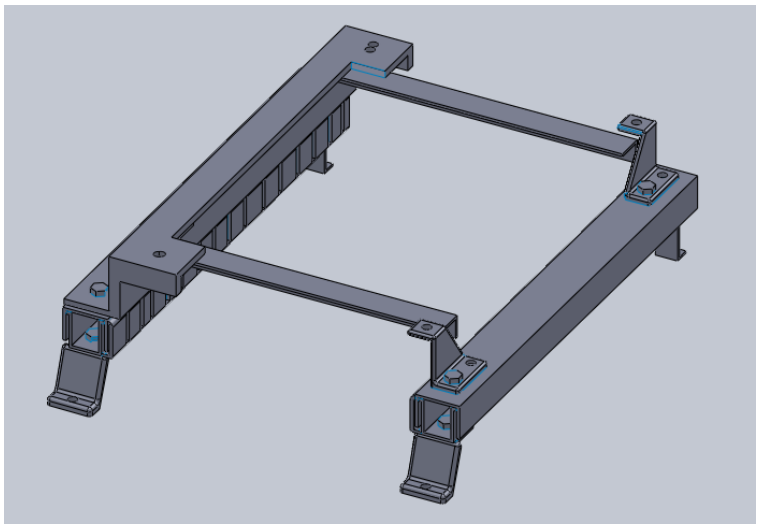

Figure 3.3 design 3

3.3 DESIGN COMPARISON

Table 3.1 shows the design comparison for the three design concepts. The design must follow up the problem that was considered. The concept variants were list to know which design can be the best for the final design according the important criteria. The design that has the highest total score was chosen to be developed and fabricated.

From the data, shows that the symbol positive, (+) means the types of selection criteria is good, the symbol of zero, (0) shows that the design has moderate criteria and the symbol of negative, (-) shows that the criteria is weak.

Table 3.1 design comparison for the three proposed design

Selection Criteria	Design 1	Design 2	Design 3
Attractive	(+)	(+)	(0)
Easy adjustable mechanism	(-)	(-)	(+)
Stable	(+)	(-)	(+)
Low cost	(0)	(0)	(0)
Small	(-)	(-)	(+)
Easy to modify	(0)	(0)	(+)
Pluses **Zero** **Minuses**	2 2 2	1 2 3	4 2 -
Net **Rank** **Continue**	0 2 No	-2 3 No	4 1 Yes

3.4 FINAL CONCEPT

The final design is chose based on six criteria stated in the Table 3.1. From the Table 3.1, it was shown that design 3 was selected as the design to be fabricated. Its score is the highest in the comparison and proves that this design is able to be fabricated in the time frame given. Compared to other two designs, all of the designs are low cost but the other two designs didn't have the criteria that design 3 had. Design 3 also in average condition where it has no minus criteria. As conclusion the best design that had been selected to be the final design for the final year project is design 3. Figure 3.4 shows the final design after undergone some modification where the small square hollow is used as seat mount. The material is welded to the design.

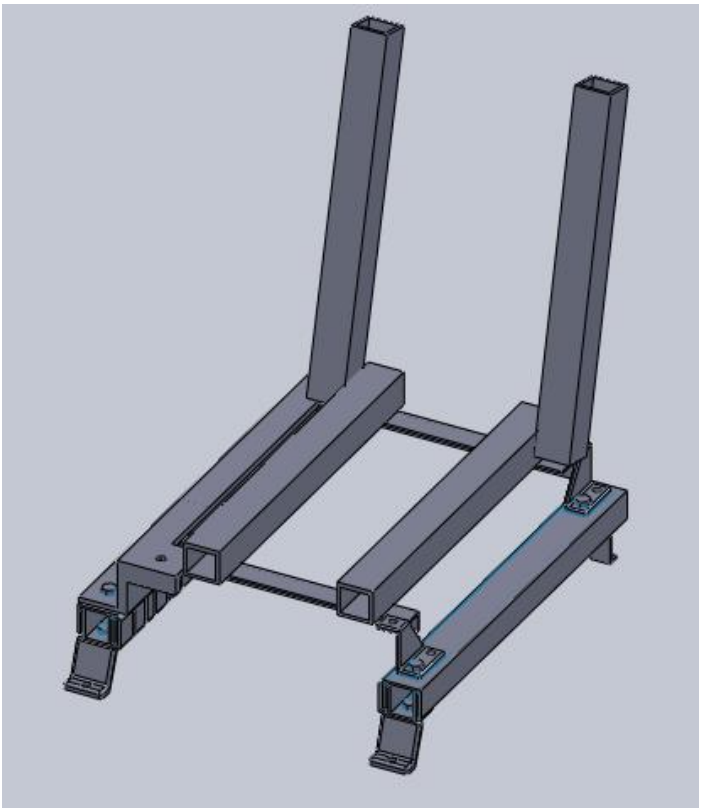

Figure 3.4 final design after being added the seat mount

All 2D drawings of design concepts and final design are shown in Appendix A. As D1 A and B are for design 1, D2 A and B are for design 2, D3 A and B are for design 3 and drawing FINAL and FINAL B are for final design.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter would explain about the fabrication process that is done to build the go-kart driver compartment. Fabrication steps including measuring, cutting, welding, grinding, drilling, fastening and finishing would be explain thoroughly to show the steps of fabricating the project.

4.2 FABRICATION PROCESS

The fabrication process is the process to make or to build the part or model of the project. This process needs to follow the exact dimension according to the drawing design. In making the design become a real product or model, several processes had been use to fabricate the go-kart driver compartment. These are the seven phases that need to be done to finish this project:

i.	Measuring	: Measure the material
ii.	Marking	: Required part that has been marked
iii.	Cutting	: Cut the material
iv.	Drilling	: Drill to make hole
v.	Welding	: Assemble the part of the project
vi.	Grinding	: To remove the over melt Welding part
vii.	Fastening	: Assemble the part of the project
viii.	Finishing	: Paint the material

4.2.1 Measuring and Marking

Before start the fabrication process, the materials must be measured and marked in order to get the required length based on the drawing. This phase is the most important step before continuing to other phases. Figure 4.1 shows the measuring tape used to measure the material. The measuring and marking process is done by using steel ruler, measuring tape and scriber (Figure 4.2)

Figure 4.1 measuring tape

Source: http://en.wikipedia.org/wiki/Tape_measure

Figure 4.2 scriber

Source: http://www.toolstation.com

4.2.2 Cutting

Cutting is the separation of a physical object, or a portion of a physical object, into two or more portions, through the application of an actually directed force. Figure 4.3 shows the cutting machine to cut the sheet metal. After measured and marked the required length, the material will be cut using the cutting machine.

Figure 4.3 cutting the sheet metal

4.2.3 Drilling

Drilling is the process that to make a hole. In Figure 4.4 shows the use of the hand drill to drill the work piece. After finish cutting the materials, drilling process take place to make a hole to assemble the seat later

Figure 4.4 the process of drilling

4.2.4 Welding

Welding is a fabrication or sculptural that joins materials, usually metals or thermoplastics, by causing coalescence. In Figure 4.5 shows the welding process that must do to join the part of material to make the seat mount on the adjustable mechanism. After cutting the material, the fabrication continues by assembling all the parts by using welding process. The welding that used in this project is shielded metal arc welding (SMAW).

Figure 4.5 weld the part of the seat mount

4.2.5 Grinding

Figure 4.6 shows the grinding process using the Bosch grinder. After finished welding, next step is grinding to dispose the over melted welding part. This is one of ways to make ensure the surface is well finished.

Figure 4.6 grind the seat mount part

4.2.6 Fastening

A fastener is a hardware device that mechanically joins or affixes two or more objects together. Figure 4.7 shows the fastening process for this project. Figure 4.8 shows the fastener used in this project which is screws. Few screws with two different length and diameter used to assemble the seat on the mount and the adjustable mechanism to the chassis.

Figure 4.7 fastening process to assemble the seat on the mount

Figure 4.8 screw fasteners used in this project

Source: http://www.chinafastener.com/suppliers/Self-clinching-screws-c157/

4.2.7 Finishing

Figure 4.9 shows the finishing process for the project. After done with fabrication process, the project will undergone the finishing process. For this project painting was choose as the finishing process. This is one way to avoid the project from corrosion. Besides that, it will make the project look more attractive and interesting.

Figure 4.9 finishing process of the project

4.3 SAFETY PRECAUTION DURING WELDING PROCESS

4.3.1 General

In the process of handling welding equipment, safety is very important things before starting a job because it can prevent injury to personnel. The extreme caution must be taken seriously and should be practice when using any types of welding equipments. Injury can result from fire, explosions, electric shock or harmful agents. Both general and specific safety precautions listed below must be strictly observed and guideline when using welding or cut the metals:

i. Make sure before using welding machine equipments request permission from the person in charge.
ii. Do not weld the material with wooden floors, unless the floors are protected with fire resistance fabric, sand or other fireproof material.

iii. Remove all the material that can caught on fire easily such as cotton, oil, gasoline and others from the vicinity of welding.

iv. Make sure before welding or cutting, warn those in proximity area who are not protected to wear proper attire.

v. Remove any assembled part from the component that being welded that may become warped or otherwise damaged during the welding process.

CHAPTER 5

RESULT AND DISCUSSION

5.1 INTRODUCTION

This chapter represent about the result and discussion of the project. In this chapter will mainly discuss about the finished product. Other than that, this chapter will also discuss about the problem encounter during the fabrication process throughout the weeks.

5.2 FINAL PRODUCT

Figure 5.1, Figure 5.2, Figure 5.3, and Figure 5.4 show the final product of this project.

Figure 5.1 the adjustable mechanism

Figure 5.2 final products after few weeks fabricating

Figure 5.3 final products after finishing process

Figure 5.4 the products had been assembled with the seat and chassis

5.3 PROBLEM ENCOUNTER

There were many problems encountered throughout the design and fabrication of driving compartment. While in phase designing, we are instructed to do some analysis on the parts connected to design. However, there were errors during the analysis which we cannot identified what were the problem. Moreover, we never learn detail about the analysis and some of the software installed, the analysis cannot be done. Then, while in fabrication phase, lots of problems occur where the equipments and tools are not there thus affecting our works and some of us need to bring our own tools and equipment to finish the project.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The final chapter is about the conclusion and recommendation for the project. In this chapter would discuss mainly about the conclusion of the project, concluding all the process that involved. Besides that, this chapter would also include about the recommendation that can be done for this project to improve it in the future.

6.2 CONCLUSION

In conclusion, the project objectives were achieved. The objective of the project is to design and fabricate the driver compartment was achieved. The best design was chosen and being fabricated within the time given. The fabrication process required many skills that have been learnt in the previous mechanical laboratory such as measuring, cutting, drilling and welding. The fabrication process provides the experience to develop the skills and the ways to operate the machines to complete the project. Besides that, problem solving skills during completing the project were also being tested. It acts as a motivator and practices before starting the practical and in facing the challenges as an engineer in the future.

6.3 RECOMMENDATION

Recommendations to similar projects in the future are as follow. First of all would be early determination of the design software to be used in designing the product as installation and learning how to use new software at the later stage proved to be

troublesome. Other than that, the future project also can be improved by adding the safety measure such as seatbelts, side mirrors and frame at the side to protect the drivers. For the future project, the also seat can be improved which mean the structure of the seat that give comfort and safety for the drives.

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APPENDIX A

DRAWING

D1 A shows 3D drawing for design 1 in isometric view

D1 B shows 3D drawing for design 1 in autographic view

D2 A shows 3D drawing for design 2 in isometric view

D2 B shows 3D drawing for design 2 in autographic view

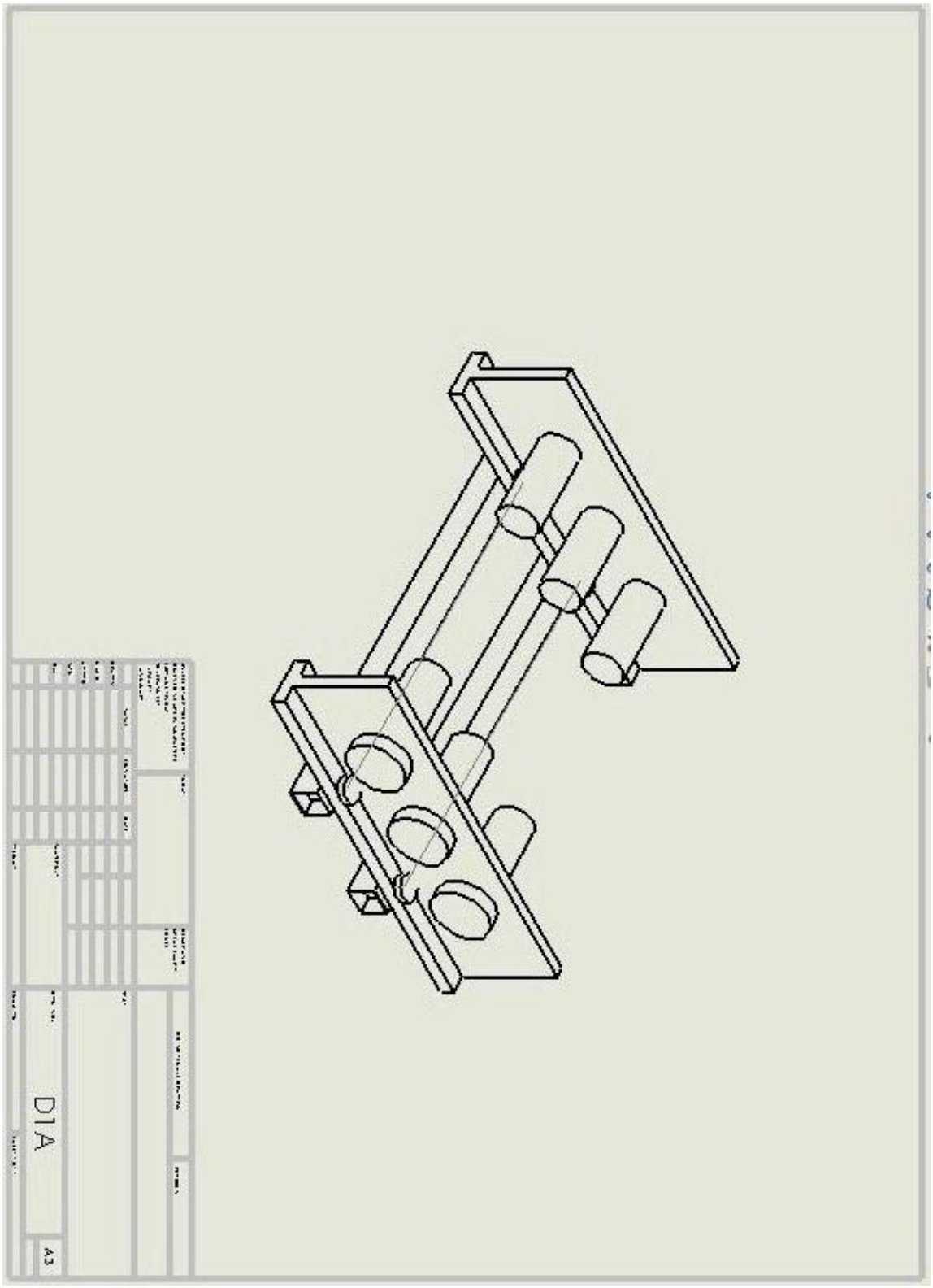
D3 A shows 3D drawing for design 3 in isometric view

D3 B shows 3D drawing for design 3 in autographic view

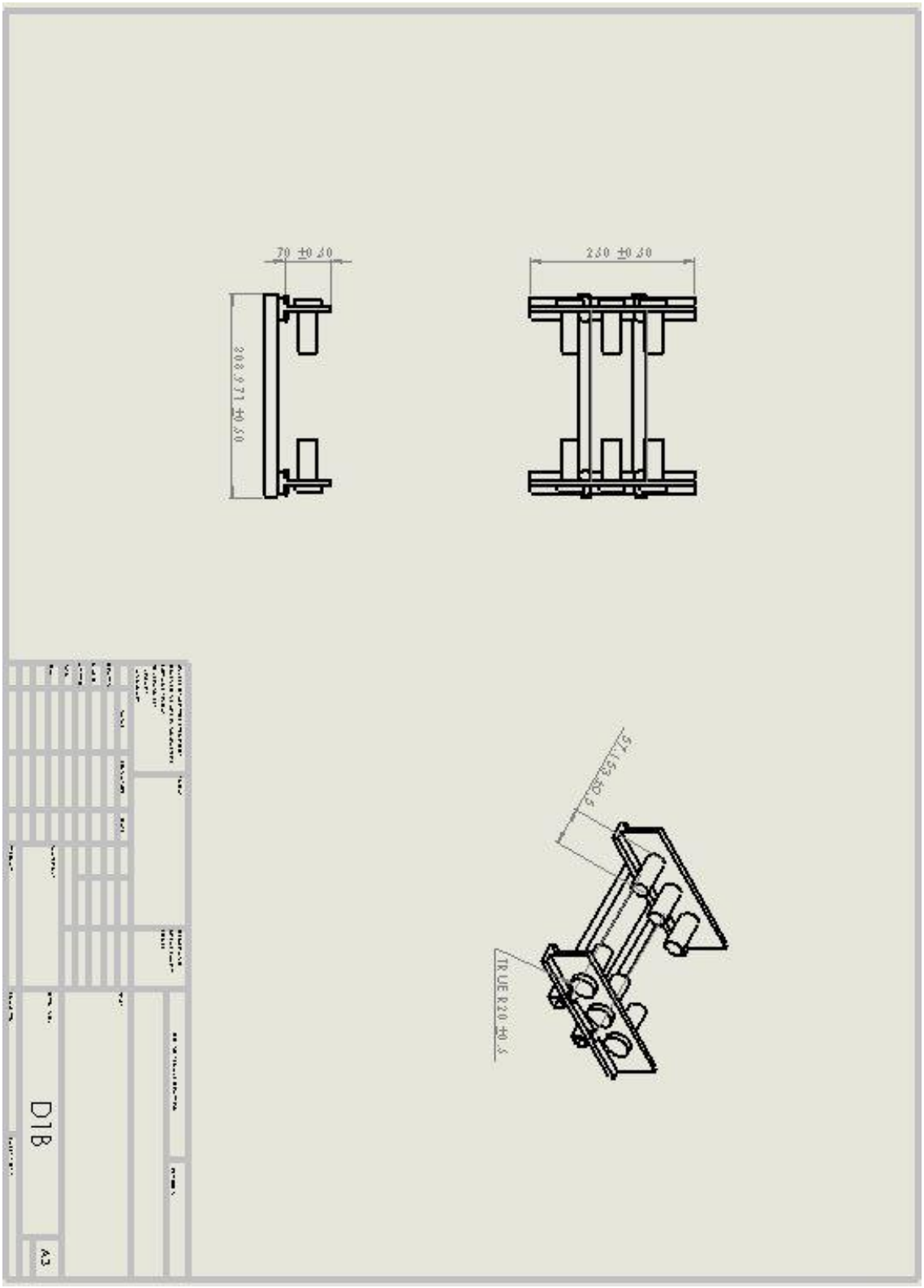
FINAL shows 3D drawing for final design in isometric view

FINAL B shows 3D drawing for final design in autographic view

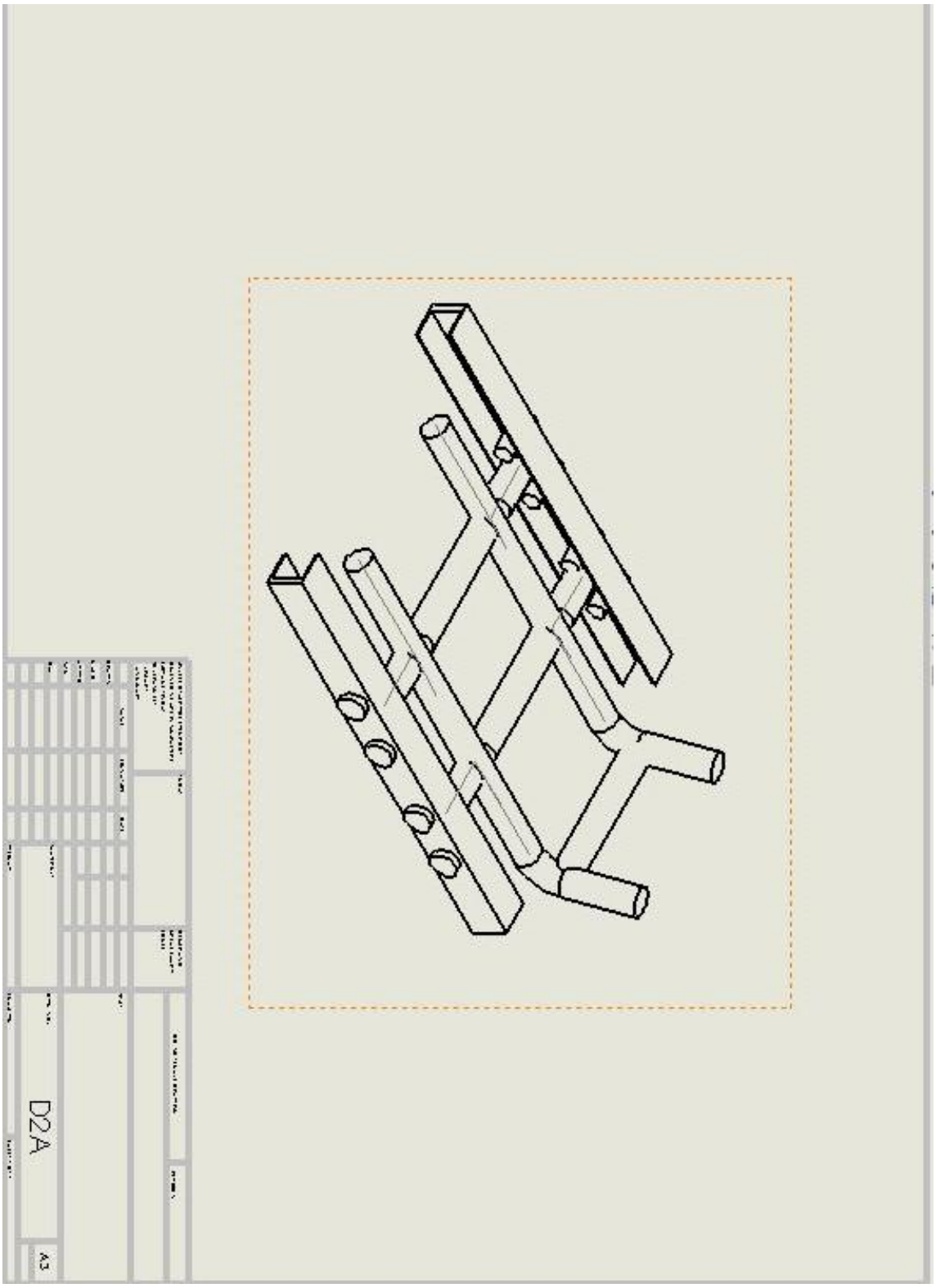
D1 A



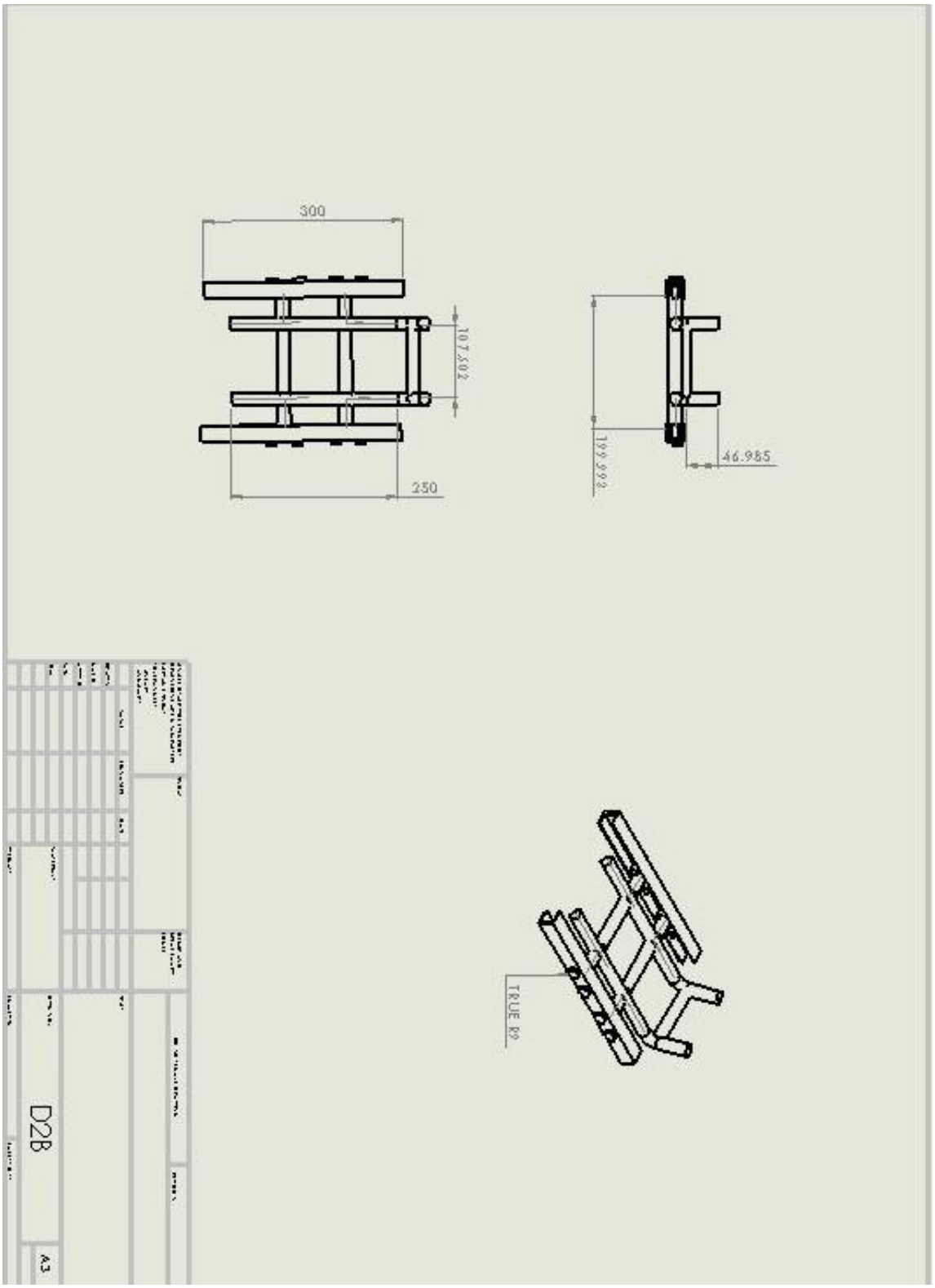
D1 B



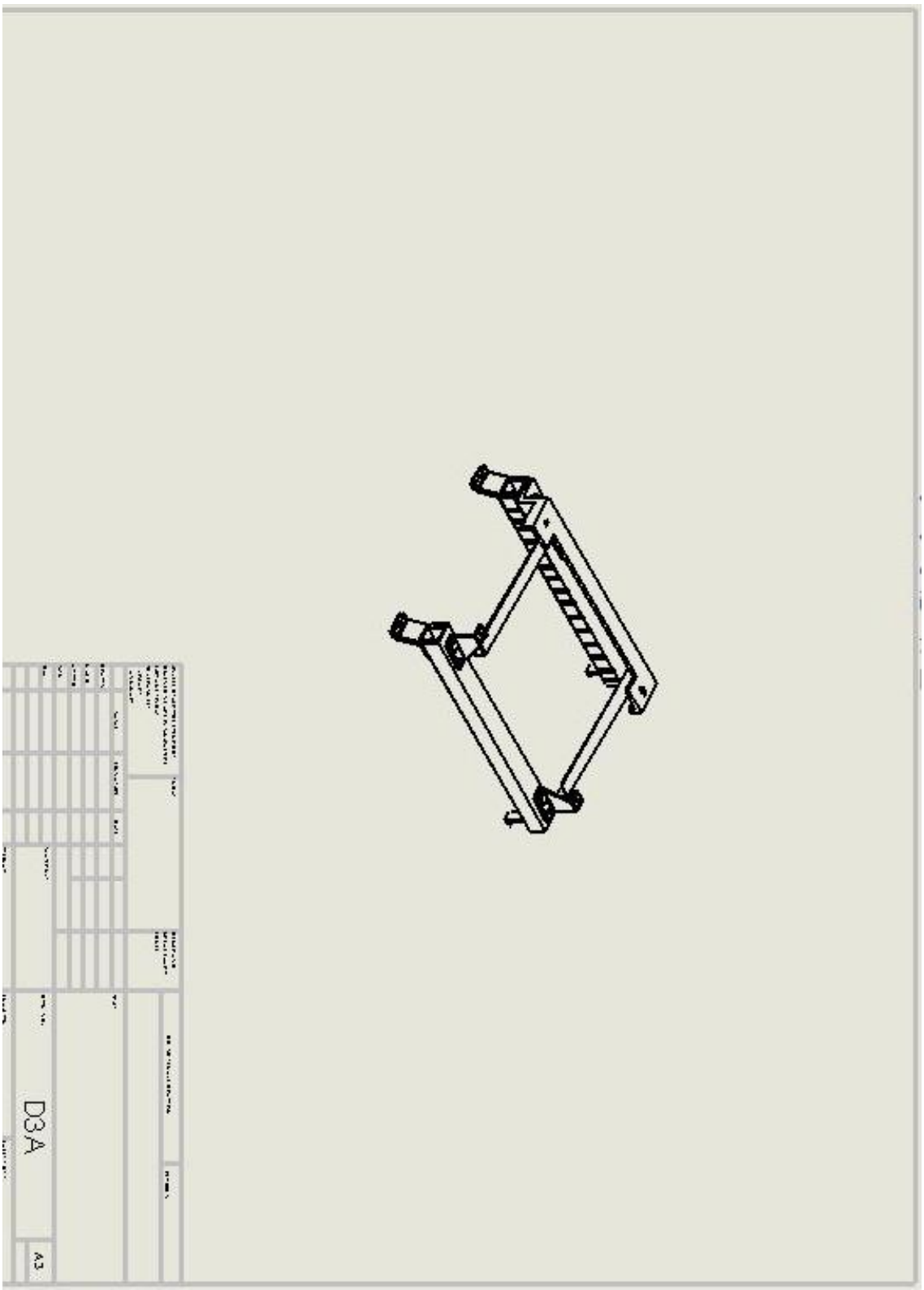
D2 A



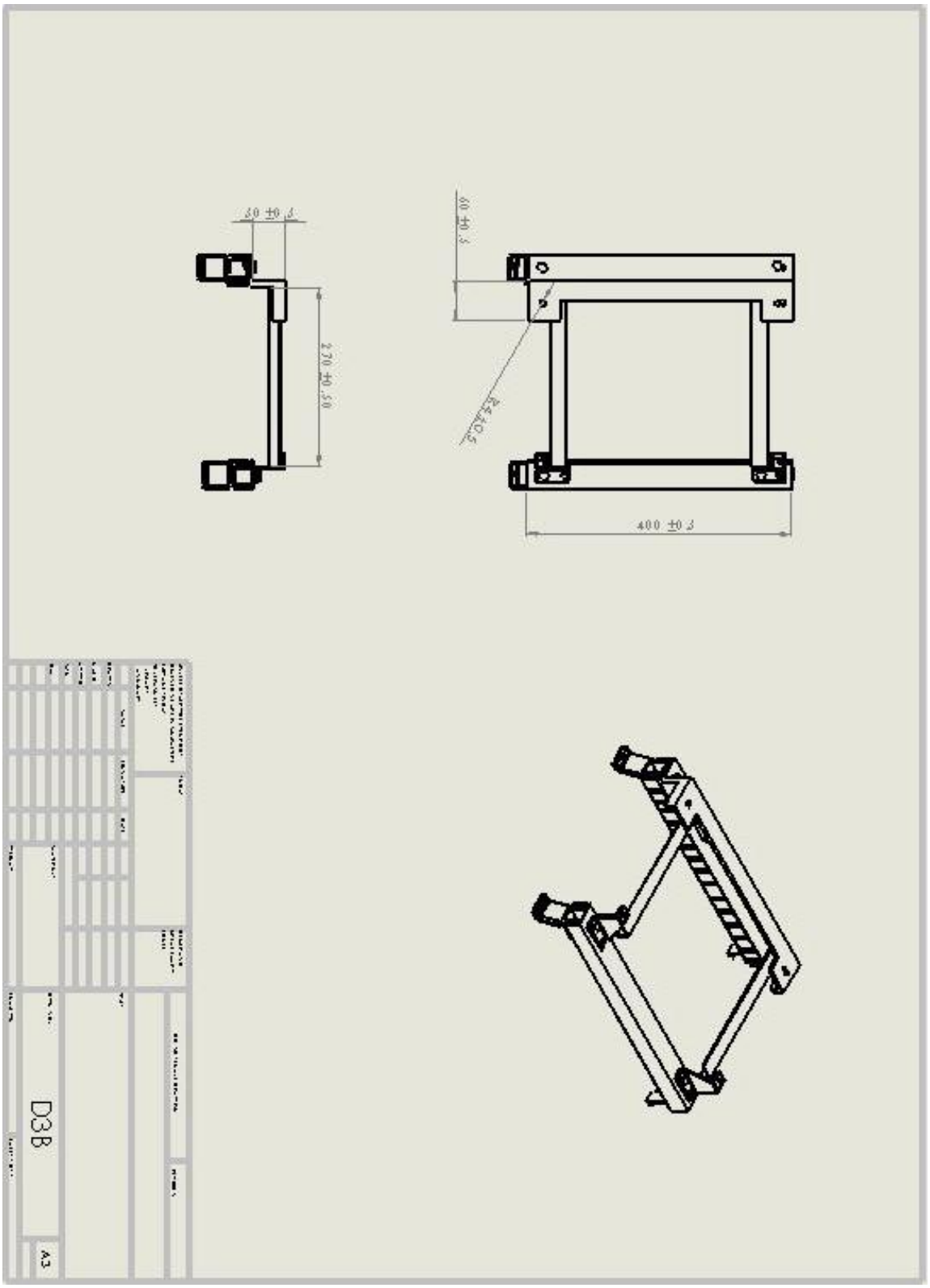
D2 B



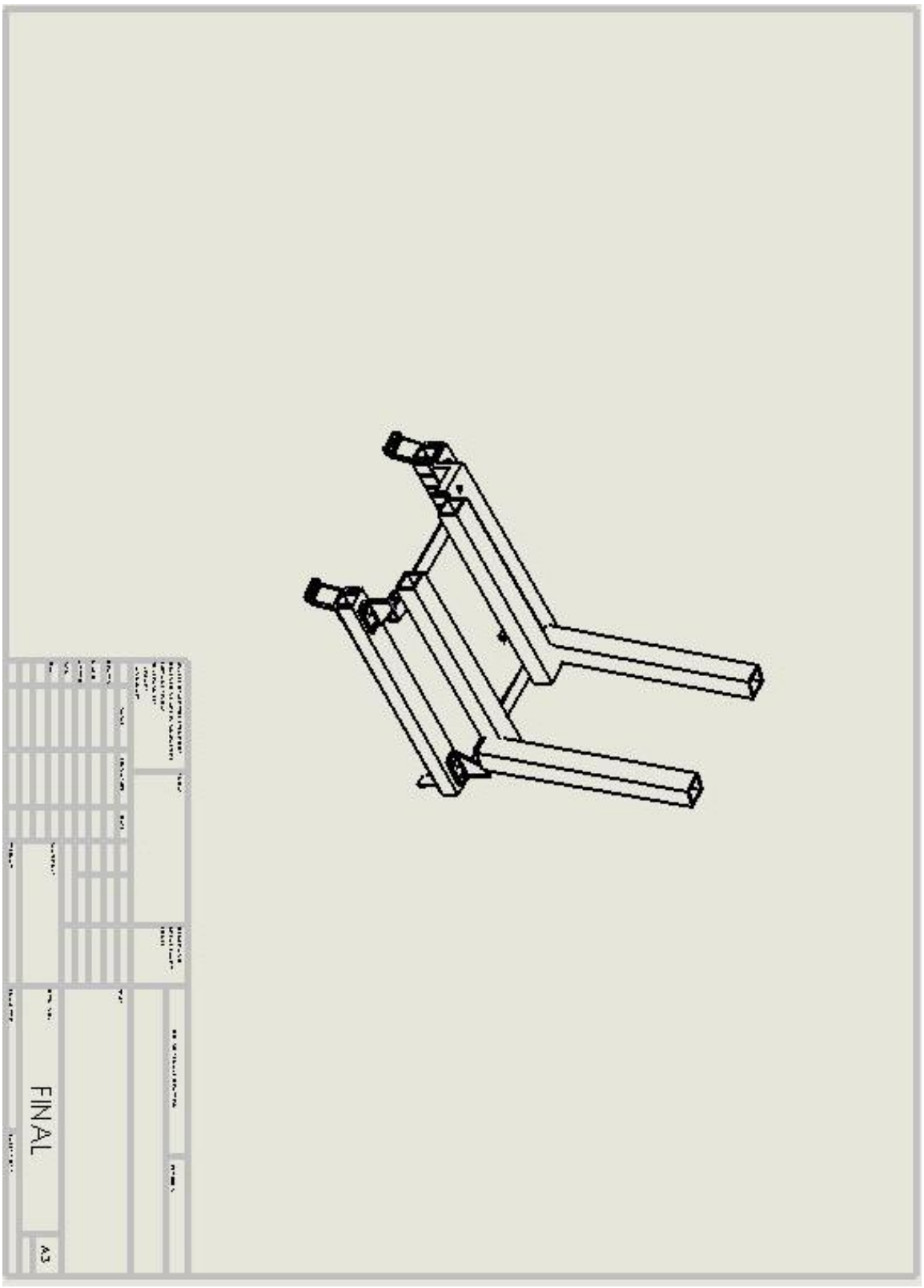
D3 A



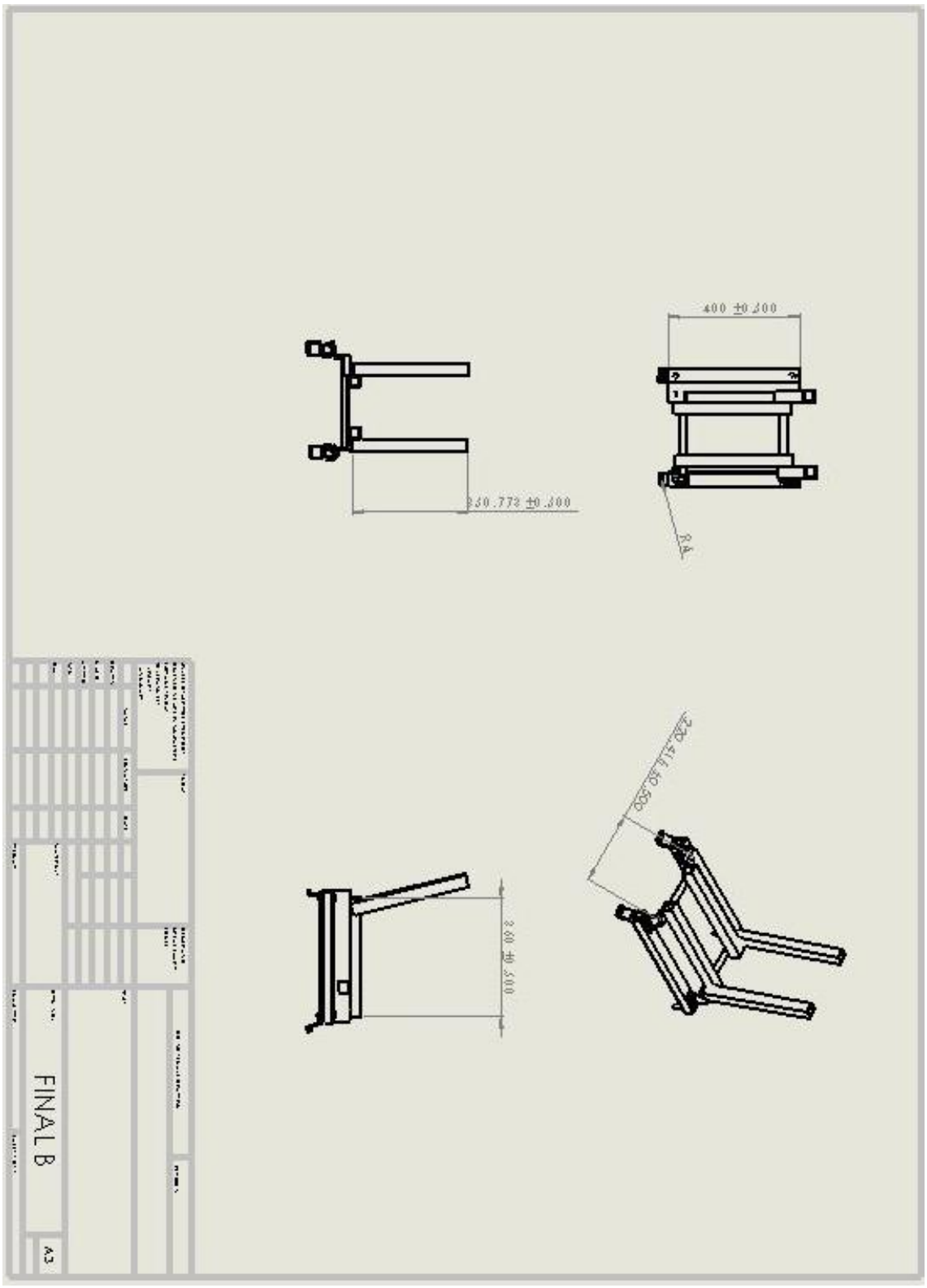
D3 B



FINAL



FINAL B



APPENDIX B

Figures of machines

B1 Floor cutting disc machine

B2 Drilling machine

B3 Welding machine

B4 Hand grinder

APPENDIX C

Figures of safety tools / wears

C1 Welding shield

C2 Gloves

C3 Apron