Car Seat Design Project

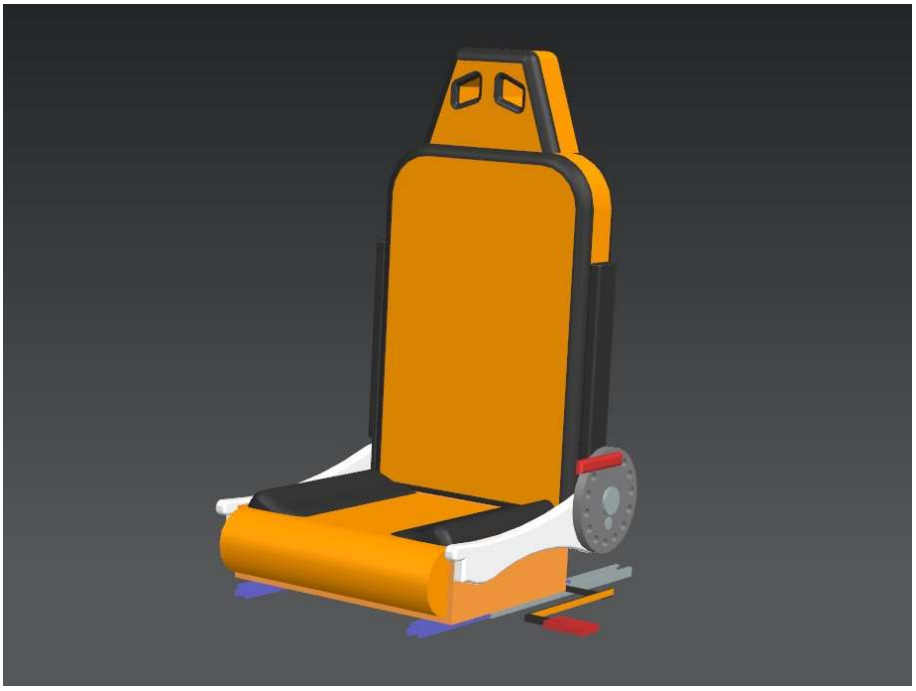


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Introduction

Cars have become a staple of society since the very first Mercedes back in 1901 [1]. As cars evolved, so has the need for adequate seats. In the modern world, car seats can be divided into two categories, first generation and second generation [2]. The main differences between both can be seen in figure 1 below. For the purpose of this design project, the main focus will be first generation seats. The two main mechanical mechanisms in focus will be adjustable position relative to the steering wheel and recline of the car seat.

Feature	*First generation*	*Second generation*
Technical principles	Mechanical	Electric-electronic
System	Manual	Intelligent
Design	Simple/integral	Complex/modular
Safety	Not very important	Main/critical element
Interactivity	Low	High
Element	Rigid	Flexible
Production	Traditional	Modular
Weight	Heavy	Light
Functionality	Single	Multiple

Figure 1: Topology of fiesta and second generation seats [2]

This report will present and explain a design for a first generation car seat with the two basic mechanisms. Everything from the design process to the CAD model and animation will be present in the report, along with a full package of engineering drawings. A thorough investigation in patents, industry standards, and economic analysis on the design is also conducted and included.

Background Study

Study of Patents

In the 1980s, there were a number of patents filed which pertained to the car seat position adjustment and reclining. Two such patents are US4765582A and US4561694A. For the remainder of this section, patent US4765582A will be referred to as 582A and patent US4561694A will be referred to as 694A.

Patent 528A was filed by I I COX Ltd in 1986 and expired in 2006 [3]. The patent was for a mechanical seat adjustment system for the front seats of a motor vehicle. It was invented by Fredrick W. Babbs, and consisted of a slide mounting assembly on either side of the seat. The assembly had a fixed and moveable slide, which allowed for a means of controlling sliding and height adjustment. This could be done by both an electric motor and a mechanical lever. The driving gear is in the space between the walls of the moveable slide as seen in (24) in figure 2.

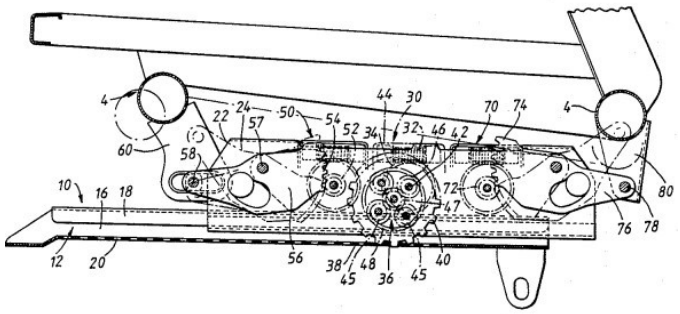


Figure 2: Mechanical Seat Adjustment Mechanism [3]

Patent 694A was filed by Tachikawa Spring Co Ltd in 1983 and expired in 2003 [4]. The patent was for a reclining adjuster for car seats. It was invented by Hideto Mouri and Nobuhiro Inoeu, whose aim was to provide a novel reclining adjuster without any drawbacks. There are a total of three embodiments of the invention, each of which can be modified and adjusted. The overall objectives of the invention are;

1. Provide an adjuster that allows the seat to recline to a wide extent and angle
2. Provide a striker which is not exposed out of the seat
3. Provide an adjuster that can be operated smoothly and comfortably

These objectives are achieved by placing a striker at the lower part and inside of the seat and by making sure that the working amount needed to operate the knob is not varied regardless of the position of the lock pin to the striker.

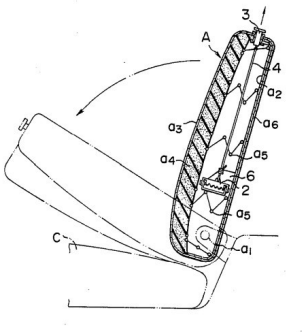


Figure 3: Side view of first embodiment [4]

Study of Standards

A car seat plays a major role in the safety and comfort of drivers and passengers. Its main purpose is to provide safety, comfort and support while meeting public and legal expectations. A standard car seat is designed to support thighs, buttocks, back and the head [5]. The seats can be divided into three main components, the squab, the base and the headrest [6]. It is standard throughout all vehicles to construct these components using a cushioning agent, usually foam. It is especially important to use the right cushioning agent when you take into consideration that a moving car can emit a vibrational frequency similar to the spine's resonant frequency [5].



Figure 4: Modern Car Seat design [5]

In 1915, the Maxwell 25 became the first car to include an adjustable driver seat [7]. When considering the importance of the driver, it is no surprise that nearly all cars since then have followed suit and it has become an industry standard. The base should be able to be moved forward and backward to adjust the distance to the steering wheel. It also must be adjustable up and down for different body types [5]. This can all be done through a mechanical mechanism or an electric motor, as we can see in the aforementioned patents as well.



Figure 5: 1915 Maxwell 25 [8]

Another feature which has become a standard in the industry is seat reclining. In a two-door car, the front seats must be able to recline forward fully to allow access to the back seats. This is also common in SUVs which may contain a third row of seats in the back. Any lever or electric motor control for reclining is generally located on the side of the base of the seat, below the cushioning. Although this concept was introduced after adjustable position, reclining for the driver seat has been around since the 1930s [9].

Both reclining and seat adjusting have become a standard in the car industry for the modern era. Not only do consumers want the added comfort and freedom it can bring, governments have begun to create standards which require both features present. The Canadian Centre of Occupational Health and Safety (CCOHS) have explicitly stated the following as a guideline when looking for a vehicle:

"When properly adjusted, the driver should be able to reach the pedals, steering wheel and other controls without stretching the legs and arms and should have a good view of the instruments, gauges, and all mirrors, and a good vision through the front and side windows." [10]

With people coming in all shapes and sizes in the current day, seat adjustability and reclining is a standard not just for comfort, but for road safety as well.

Design Process

The full CAD model picture, design and engineering drawings, and BOM can be found in the Appendix.

Selection Criteria

Criteria	**Concept Design 1**	**Concept Design 2**	**Concept Design 3**
Easy to perform simulation	**5**	**3**	**1**
Easy to CAD	**5**	**4**	**3**
Complexity of Design	**4**	**5**	**1**
Aesthetic	**4**	**3**	**1**

Comfortability	**3**	**3**	**3**
Total	**21**	**18**	**9**

Note: Concept Design with the highest total will be considered for the final design of the car seat. Concept Design 1 was selected.

Design Documentation

1. **Establish Communications With Group Members**
   Group members got together to plan out the design project. Each individual member was given a task to complete.
   Start: 11/14/2022
   End: 11/14/2022

2. **Literature Survey:**
   A survey was conducted to gather information regarding the advantages and disadvantages of existing car seat design mechanics.
   Start: 11/15/2022
   End: 11/15/2022

3. **Brainstorm Ideas:**
   A HofQ matrix was generated to get an idea of our engineering targets and specifications based on customer requirements. We then came up with ideas to design a seat mechanism that meets the requirements of the HofQ. Solutions were generated for potential issues.
   Start: 11/16/2022
   End: 11/16/2022

4. **Generating Preliminary Technical Ideas:**
   Potential design concepts for a seat mechanism were drawn on a smartboard. This helped us compare them side by side.
   Start: 11/16/2022
   End: 11/18/2022

5. **Proposal & Selection Of Design Concepts:**
   Group members presented their ideas for seat mechanism and the 3 best designs in terms of time and practical efficacy was selected.
   Start: 11/18/2022
   End: 11/18/2022

6. **Final Design Concept Selection:**
   A pros and cons list was made for top 3 designs and after thorough analysis the best design was selected. This design involves a car seat with a mechanically operated sliding and incline mechanism.
   Start: 11/18/2022
   End: 11/19/2022

7. **Design Construction Using Siemens NX:**
   A Siemens NX model was created for each part that was to be used in our seat mechanism. This Process was quite time consuming and difficult but the joint effort of each group member made it easy to carry out the process.
   Start: 11/18/2022
   End: 11/21/2022

9. **Design Adjustment:**

Various parts of the seat mechanism were adjusted to make sure it could perform the seat adjustment properly without failures. The incline mechanism needed to be adjusted to make smoother operations.
Start: 11/12/2022
End: 11/23/2022

10. **Design Assembly Using Siemens NX:**

All parts were then assembled in a single assembly file and a motion study was done on the assembly file.
Start: 11/23/2022
End: 11/25/2022

11. **Testing Design Concept & Set Final Specification:**

The final design assembly was tested and any issues that we came across were fixed.
Start: 11/25/2022
End: 11/26/2022

12. **Establish Groundwork For Presentation:**

A layout for the presentation was made and the workload was divided within the group.
Start: 11/27/2022
End: 11/29/2022

Economic Analysis

We first determined the type of material we wanted to use for our part of the car seat. We chose Leather for the seats because it is a premium luxury material that is also durable and strong. The cost of Leather is $6.95 per sq.ft [11]. The cost of steel is $0.75 per Kg [12]. The weight of the level, recliner mechanism and locking system is approximately 5 kg, and the sliding mechanism is approximately 3kg.

Part Type	Materials Used	Estimated Production Cost	Estimated Cost (Other Companies)
Car seat bottom	Leather	~ $300	$426.77
Car seat backrest	Leather		
Car seat head	Leather		

Car seat bottom case	Steel	~ $15	
Case screw	Steel	$0.10	$0.10
Lever	Steel	~ $50	$221.74
Lock Mechanism	Steel		
Recliner Mechanism	Steel		
Slider Mechanism	Steel	~ $30	$110.28

The total estimated cost of manufacturing a seat for other companies is : $758.89/seat. For our chair, we estimated the material cost for the leather by using the dimensions and taking account of the manufacturing process as well. We estimate that the total cost for our chair will be close to $400/seat.

Results

Before brainstorming ideas for a mechanical driver seat, we first had to conduct an extensive study on industry standards and previous patents. A good seat is vital for safety and comfort whilst driving. From our research, we learned that seat adjusting and reclining have been included together in every car since the 1930s. We also looked into two past patents to get a better understanding of the technology used. One patent was for the slider mechanism and the other was for the recliner mechanism. Our design of the seat had a total of 16 parts. The slider mechanism allows for adjustments in the z axis to allow for an inclusive experience for individuals of different heights.It follows a simple dual rail and track system with a lever acting as the locking mechanism. The track featured in the design has mechanical locking slots commonly seen in most commercially available car seats. The user pushes up on the lever to disengage the lock, allowing for sliding and then releasing the lever to lock the movement. The recliner mechanism allows the car seat to tilt up or tilt down using a lever. The lever in the recliner mechanism locks the tilt position of the car seat. According to our economic analysis, the total cost of one seat will be approximately $400.

Discussion

Despite the importance of being able to adjust the driver seat, it wasn’t until the 1930s that all cars had the option to adjust both the position and recline angle. The seat we have designed is not only appealing, but also successfully provides the driver with the option to slide the seat towards/away from the steering wheel. Whilst designing, we used the industry and CCOHS standards to base our slider and recliner mechanism. Overall, our design is in line with the study of standards and patents, and successfully helps improve safety and comfort, whilst being visually appealing.

Appendix

Appendix A: Initial Sketches

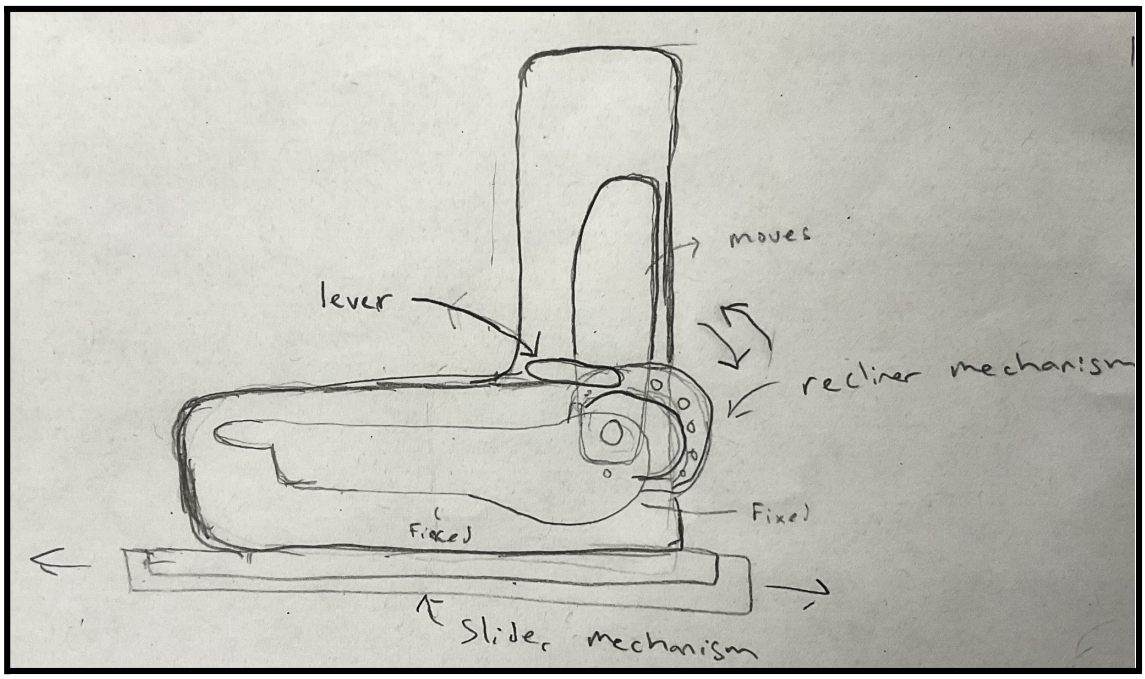


Figure 1: Concept Sketch; Car Seat with Lever reclining system

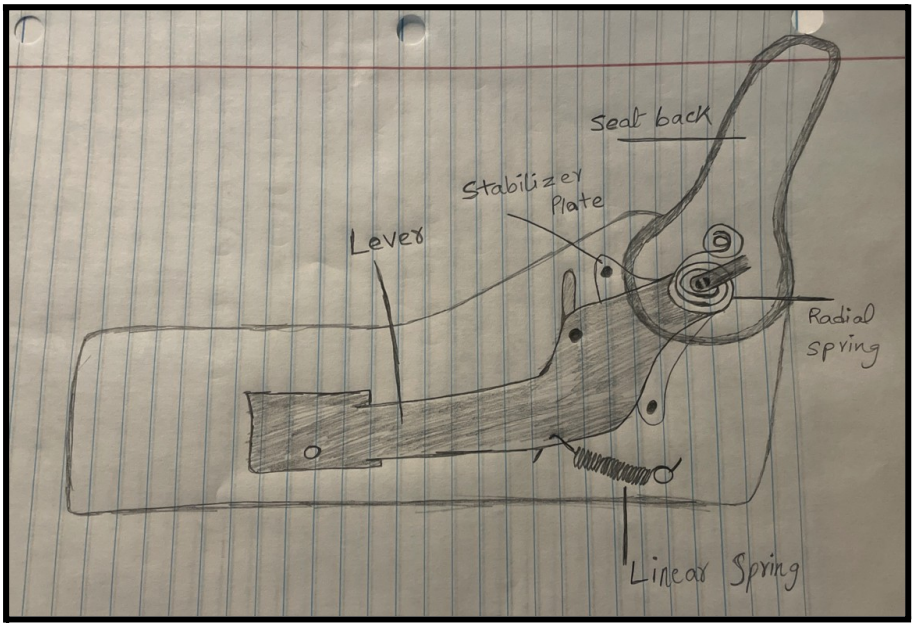


Figure 2: Concept Sketch; Car Seat with spring reclining system

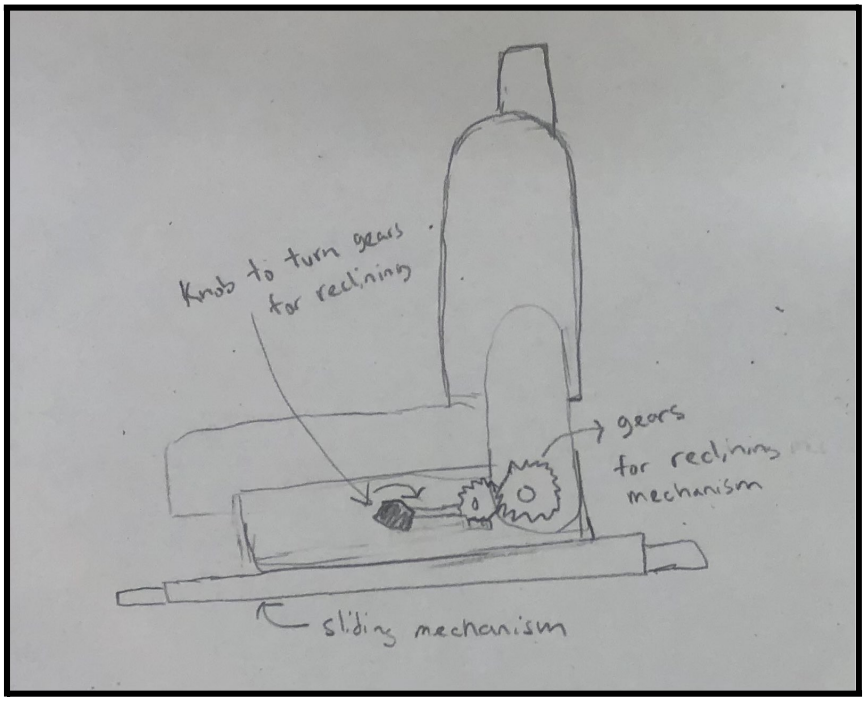


Figure 3 Concept Sketch; Car Seat with gears reclining system

Appendix B: Selected Concept

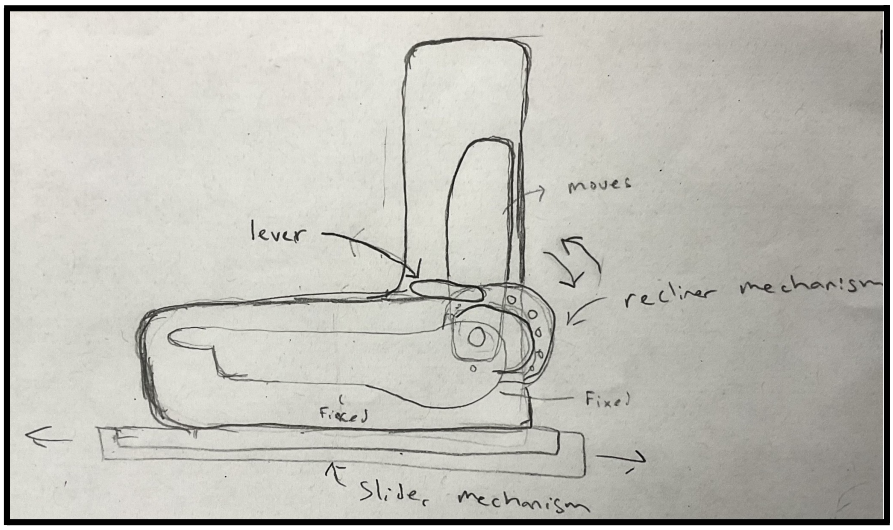


Figure 4: Selected Concept

Appendix C: Detail Design

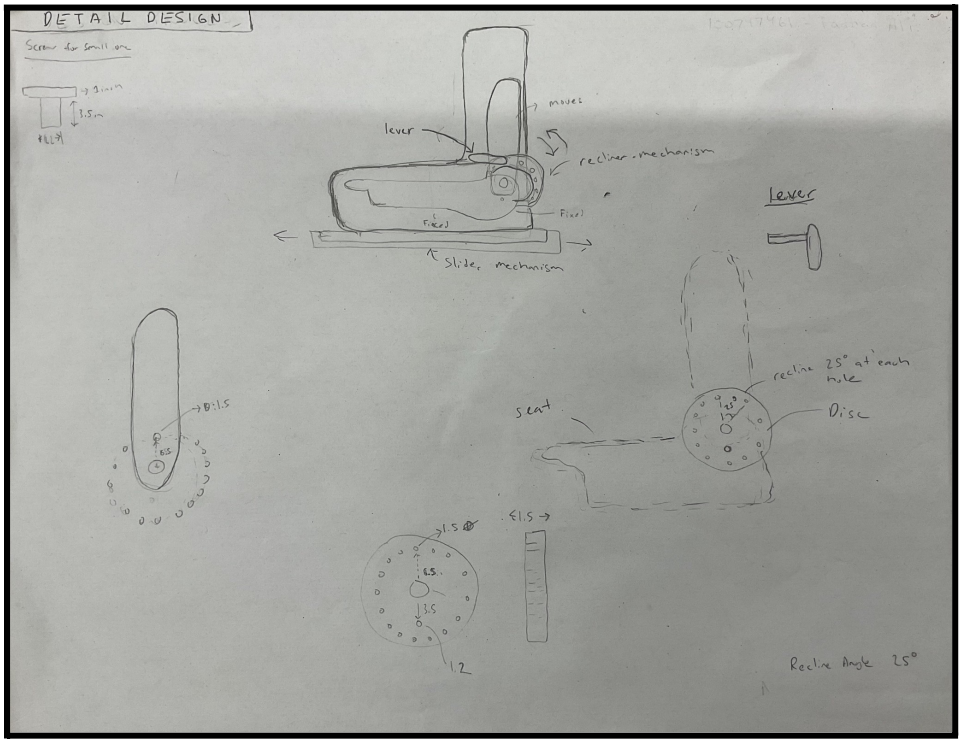


Figure 5-1: Detailed Design Page 1

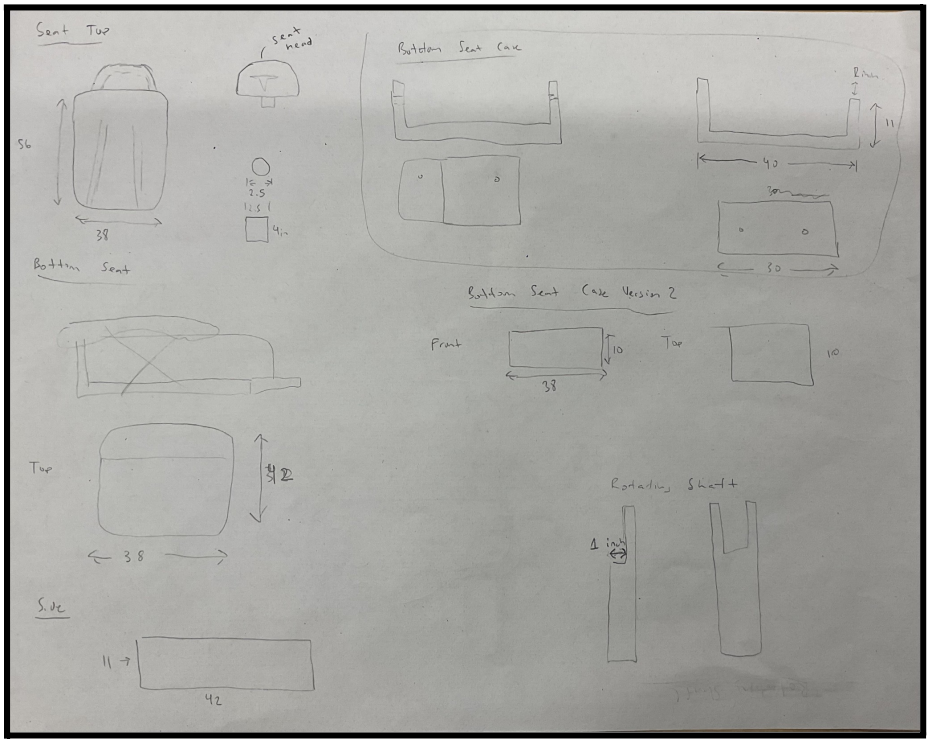


Figure 5-2: Detailed Design Page 2

Appendix D: Full CAD Model

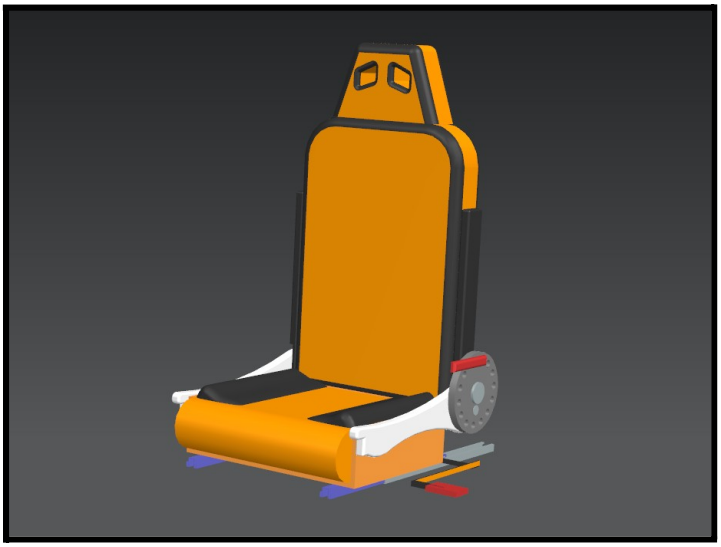


Figure 6: Assembly for the Car Seat

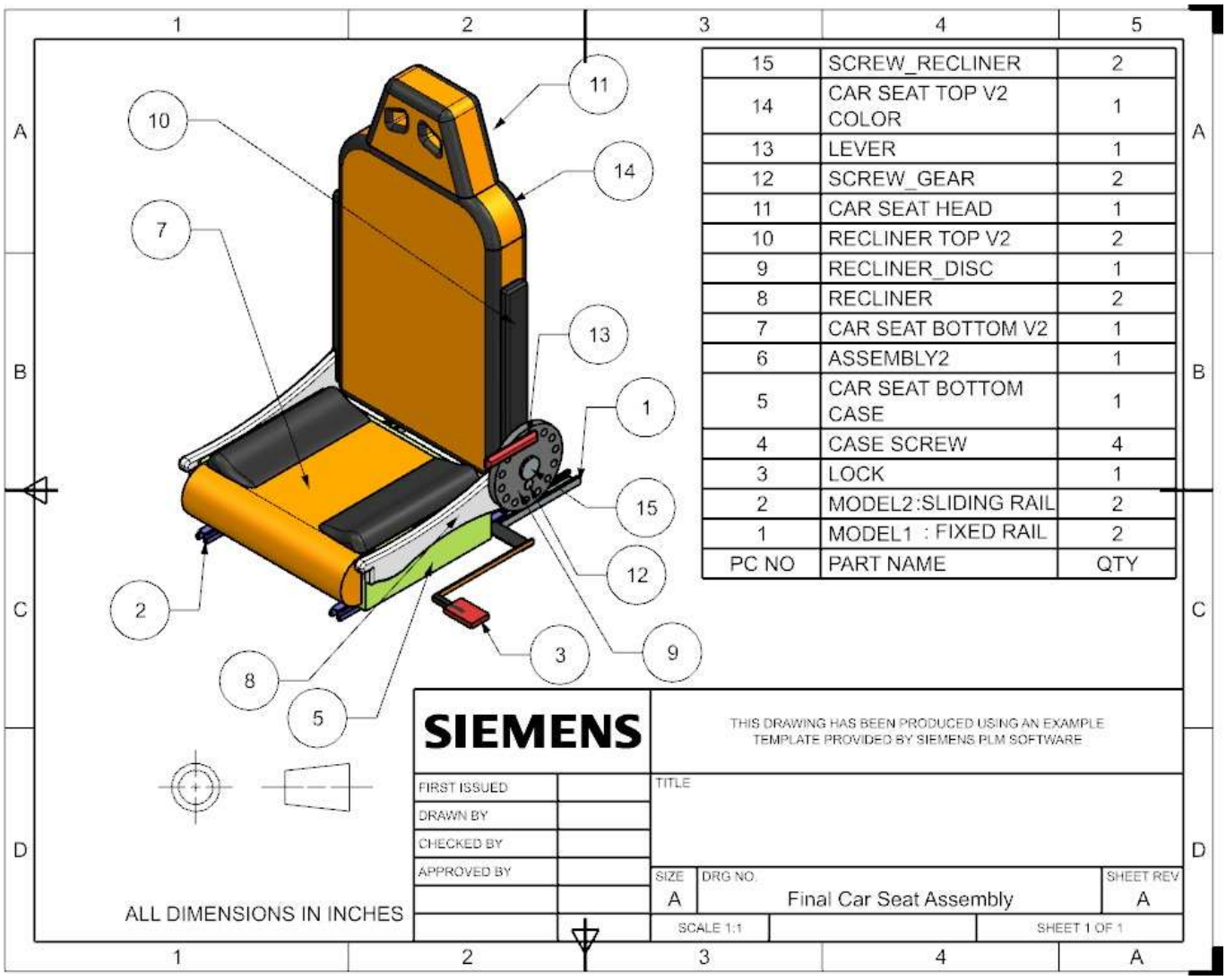
Appendix E: Animation of the motions for adjustment and reclining



Click the link below to watch the animation:

https://drive.google.com/file/d/1cQHstExFzVsAw7km82euGb2QSgBH9K65/view?usp=sharing

Appendix G: Assembly Drawings

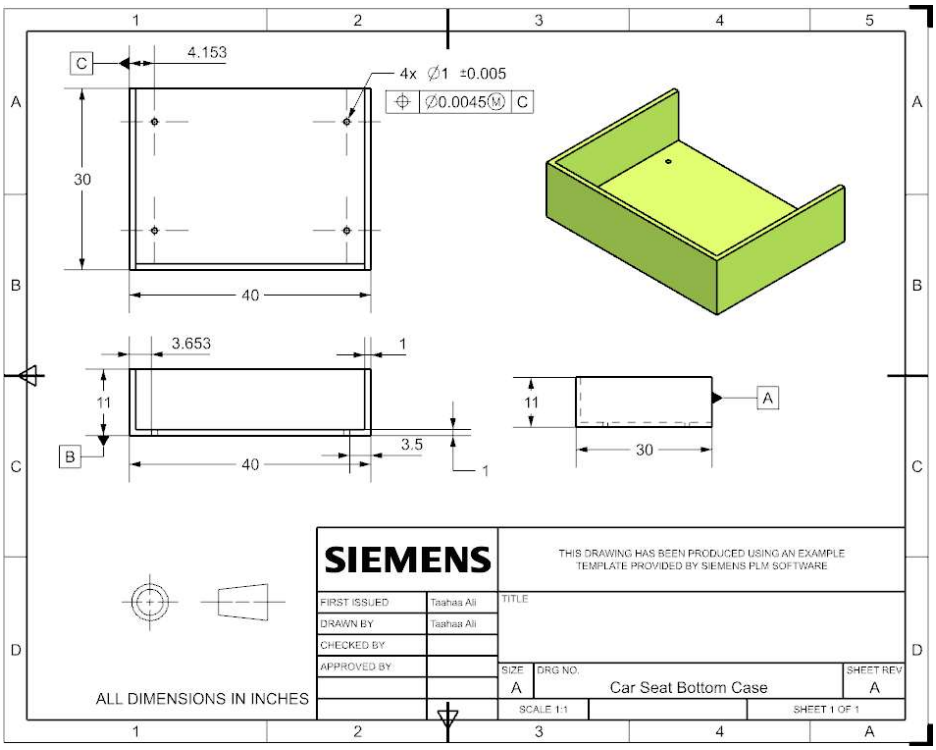


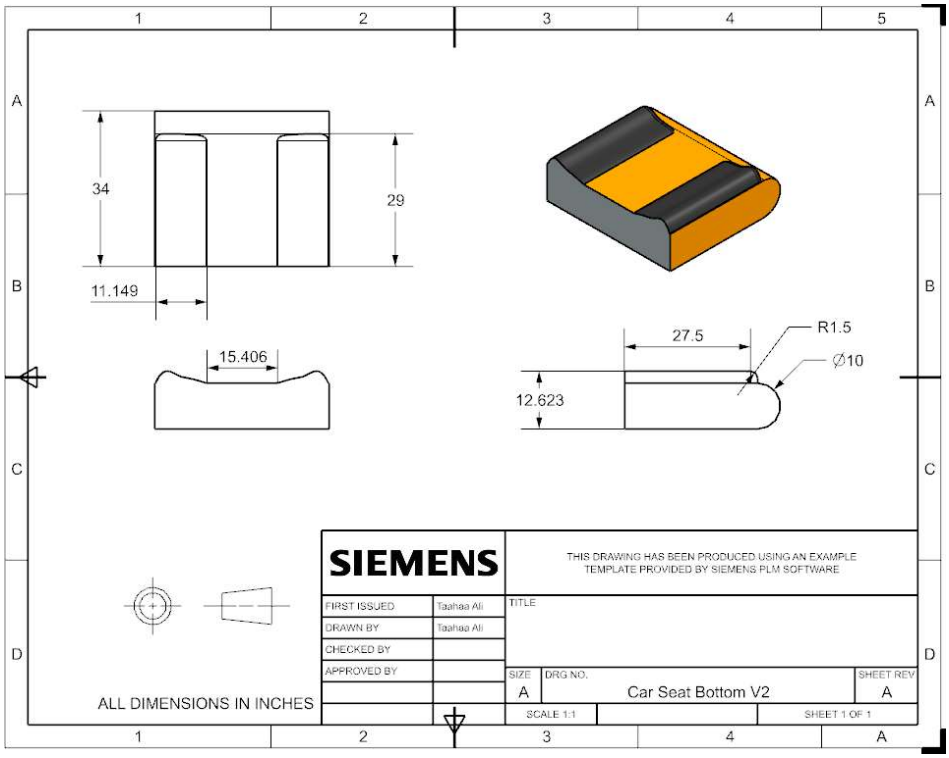
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14	CAR SEAT TOP V2 COLOR	1
13	LEVER	1
12	SCREW_GEAR	2
11	CAR SEAT HEAD	1
10	RECLINER TOP V2	2
9	RECLINER_DISC	1
8	RECLINER	2
7	CAR SEAT BOTTOM V2	1
6	ASSEMBLY2	1
5	CAR SEAT BOTTOM CASE	1
4	CASE SCREW	4
3	LOCK	1
2	MODEL2:SLIDING RAIL	2
1	MODEL1 : FIXED RAIL	2

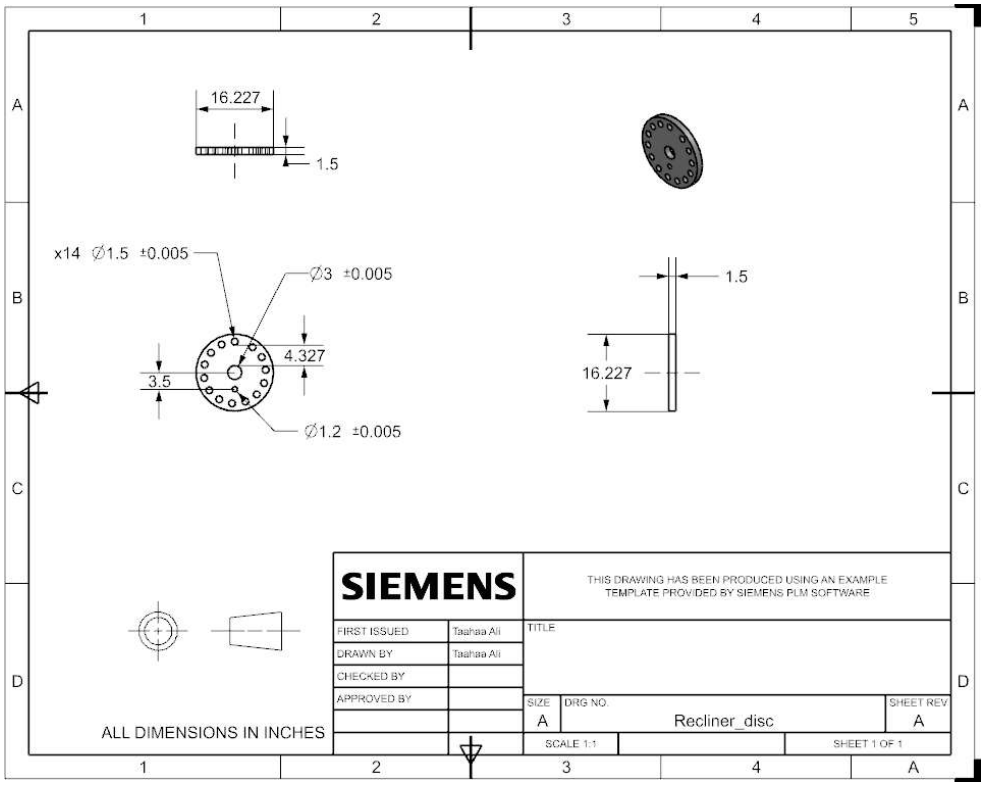
Appendix F: Bill of Materials

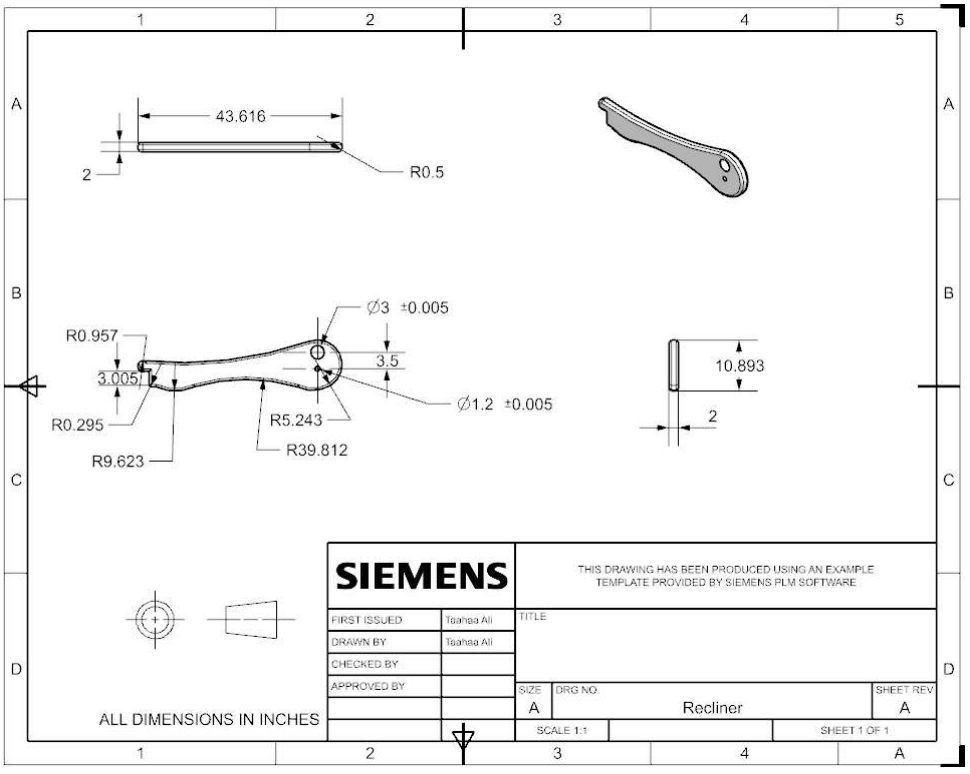
Sequence	Part	Quantity
1	Car Seat Head	1
2	Lever	1
3	Screw	8
4	Disc	1
5	Upper Recliner Support for reclining mechanism	2
6	Lower Recliner Support for reclining mechanism	2
7	Car Seat Backrest	1
8	Lower Seat	1
9	Sliding Lock	1
10	Car Seat Bottom Case	1
11	Sliding Rails for sliding mechanism	2
12	Fixed Rails for sliding mechanism	2

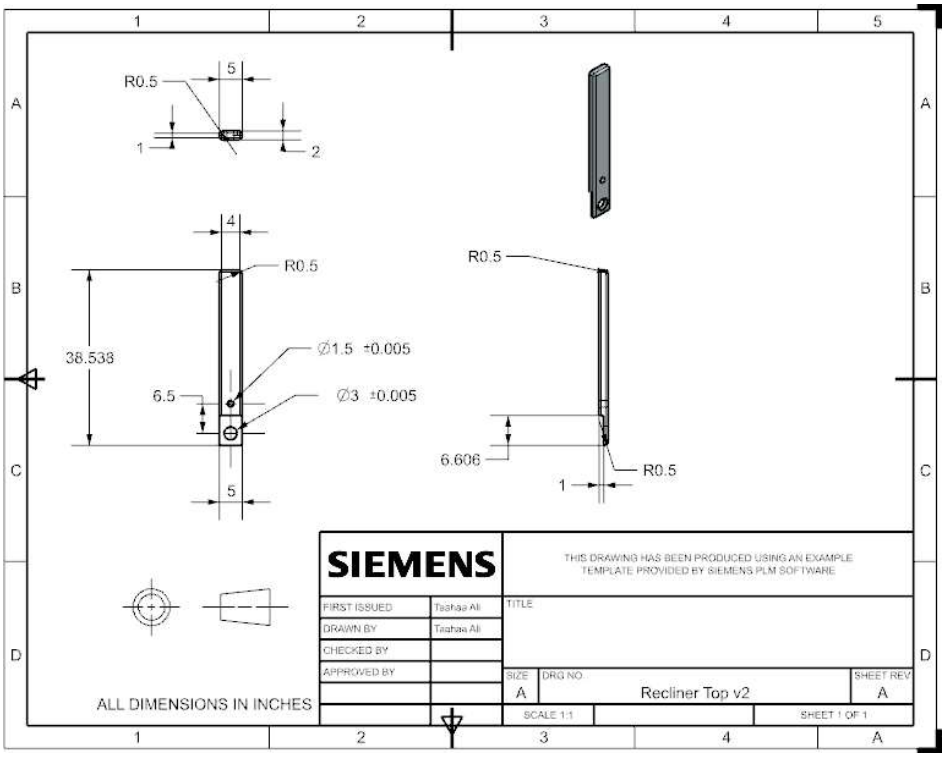
Appendix G: Multiview Drawings

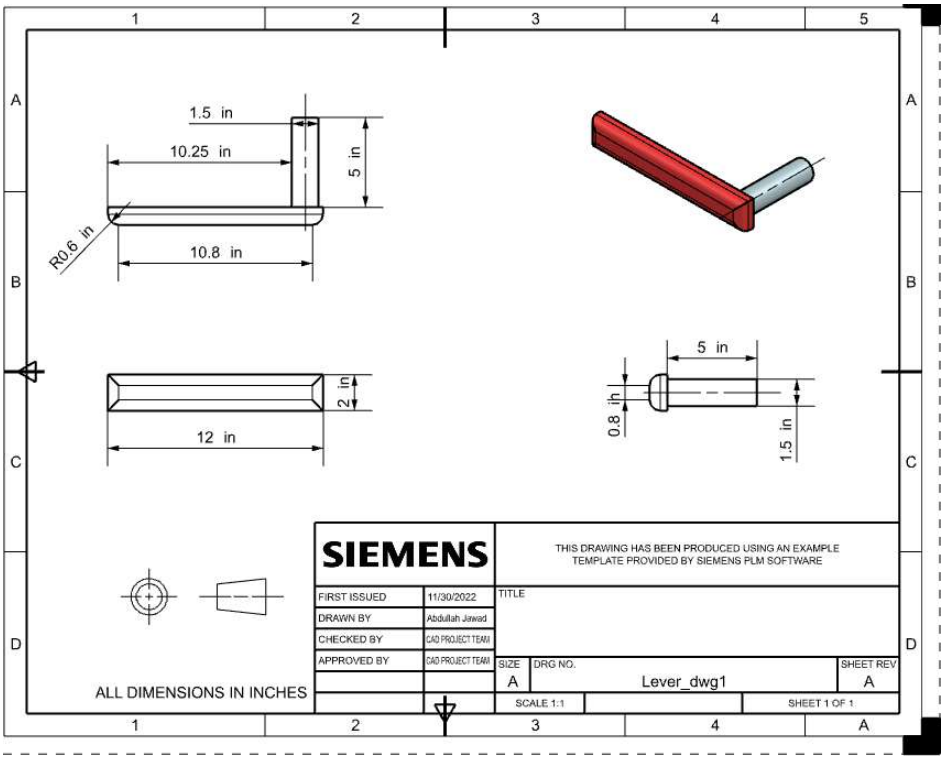


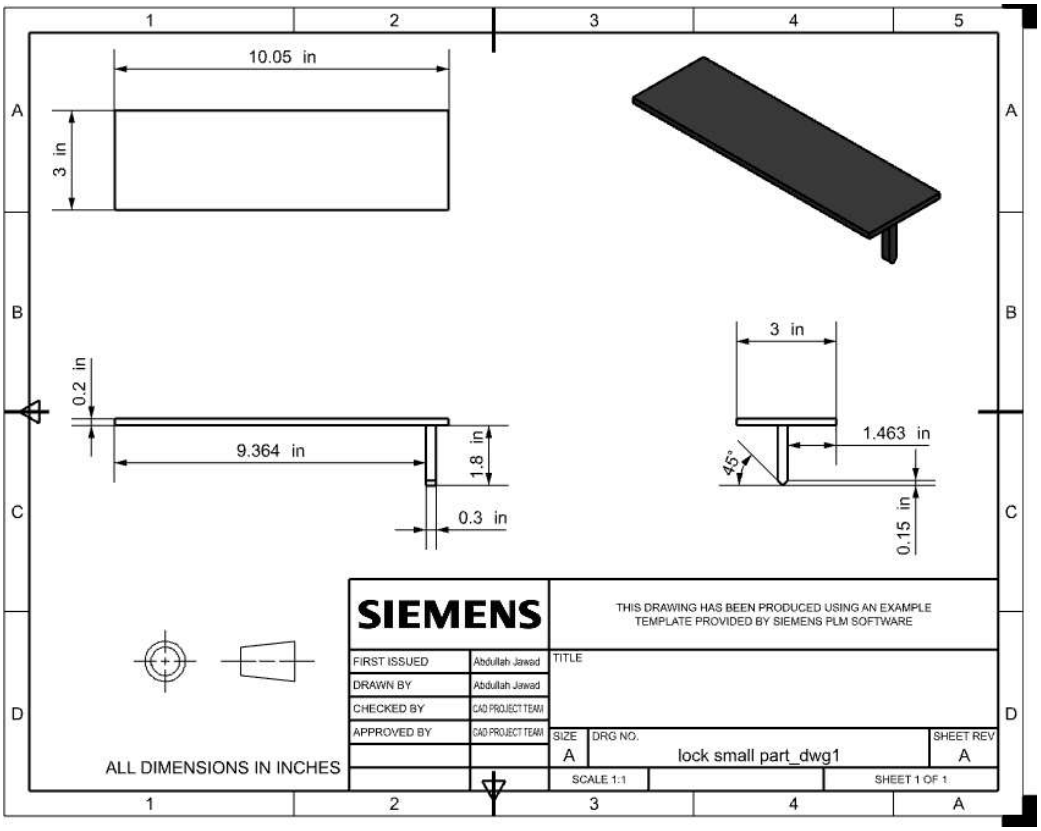


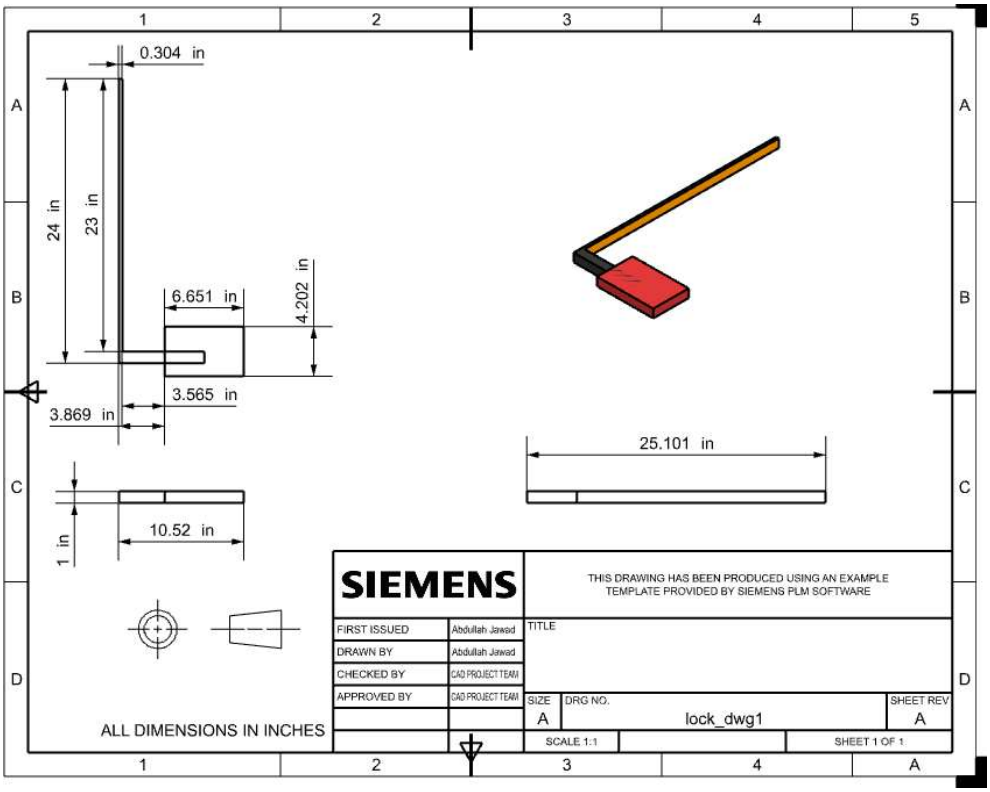

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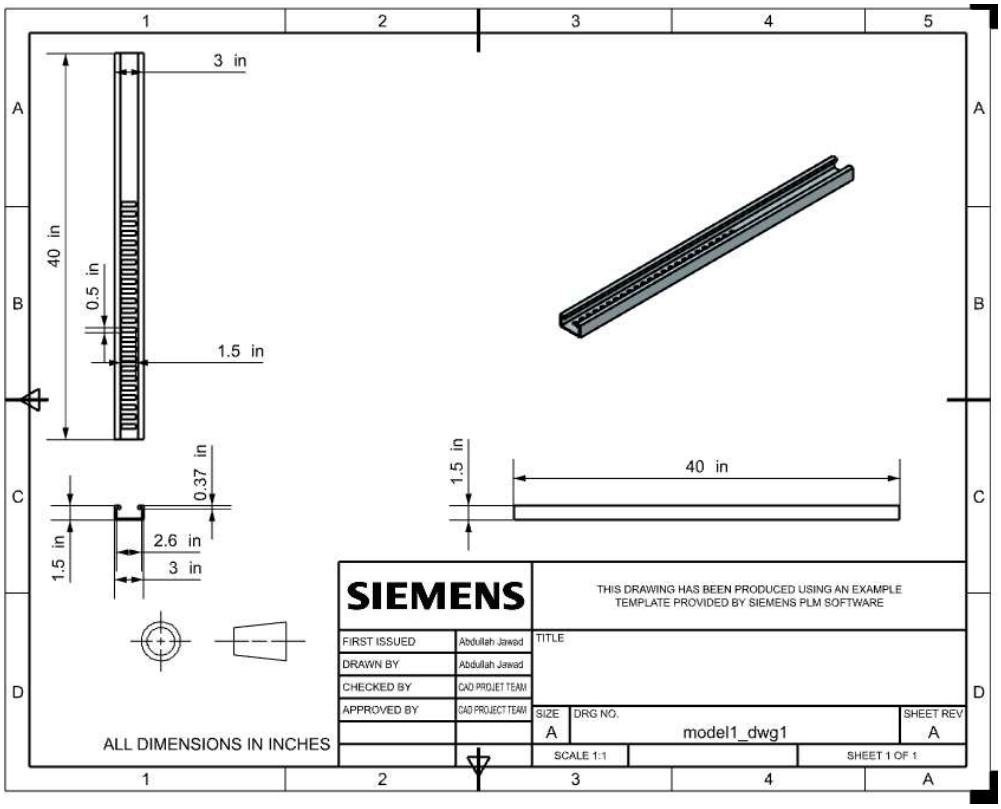

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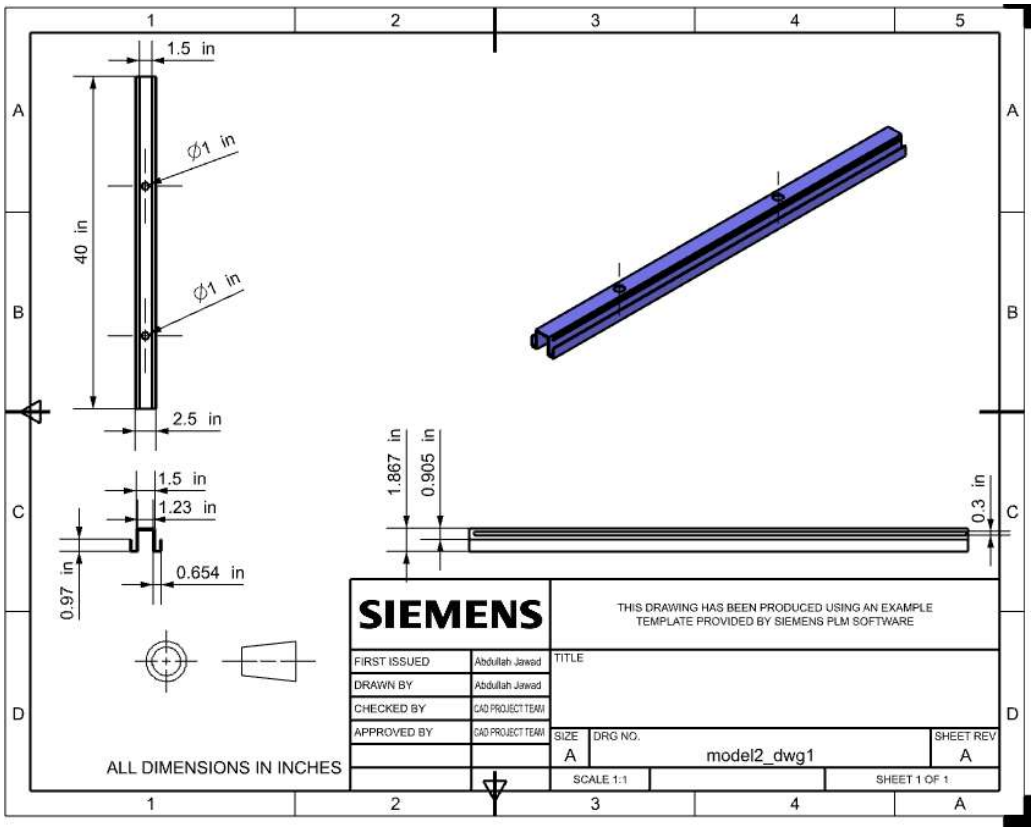

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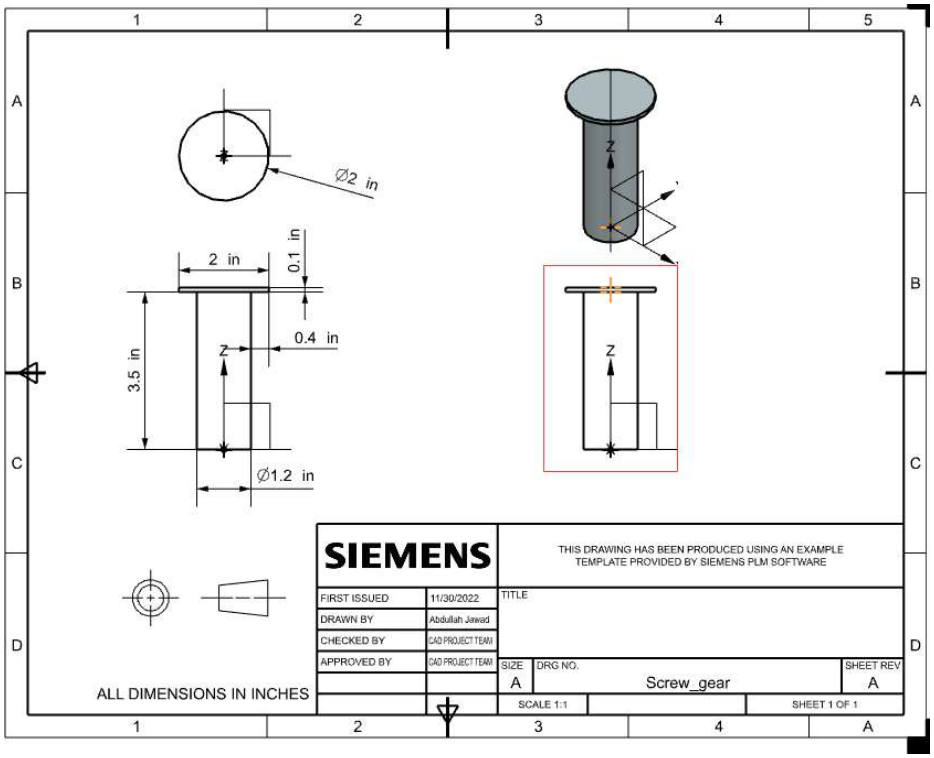

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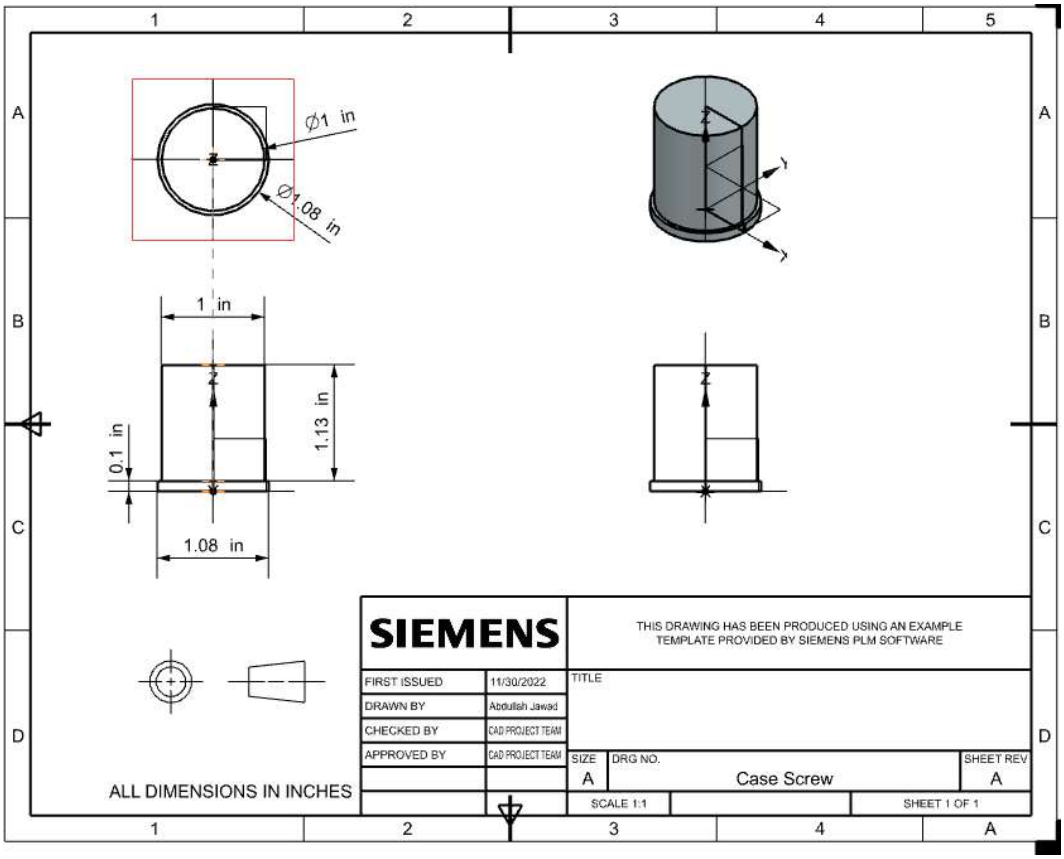

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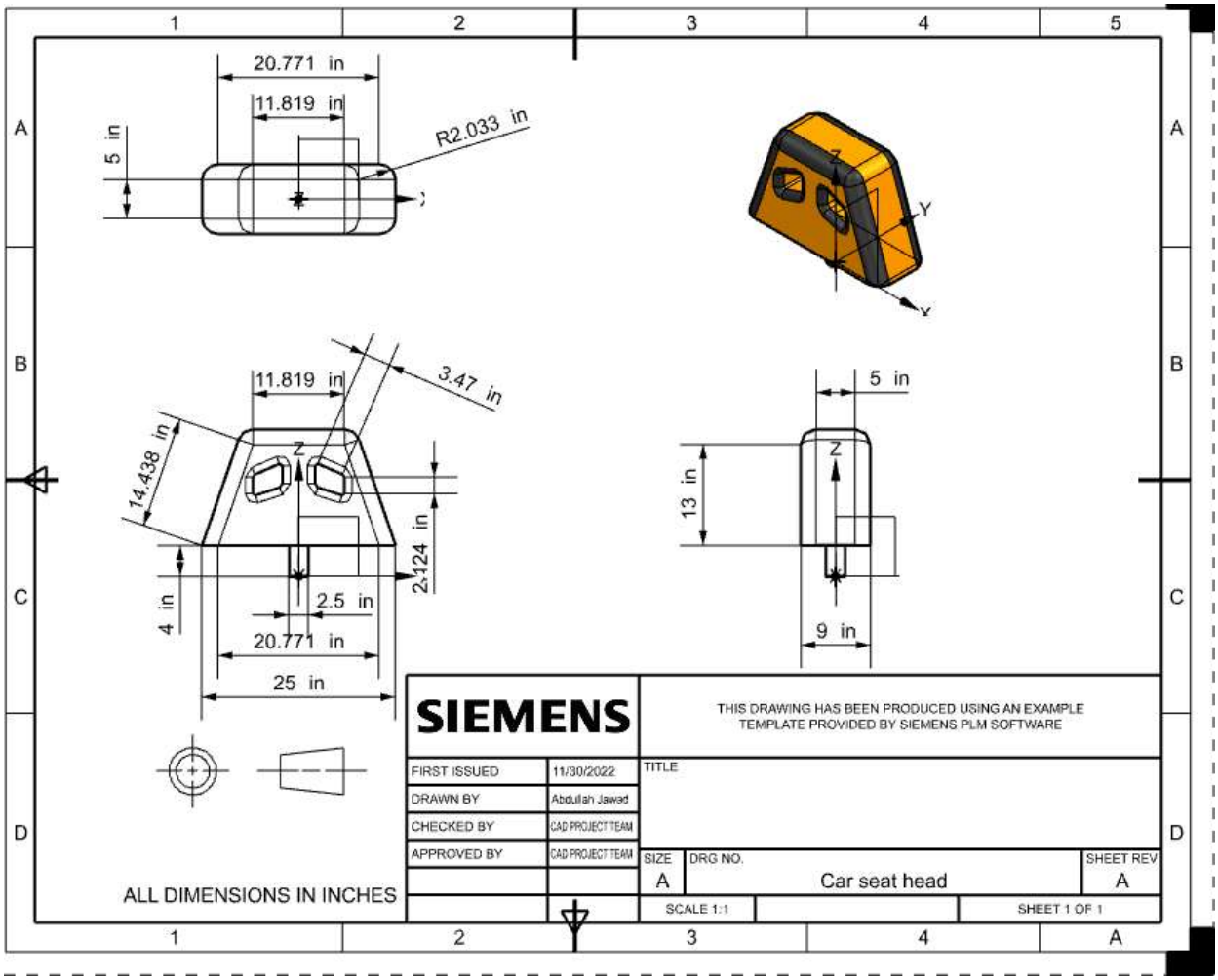

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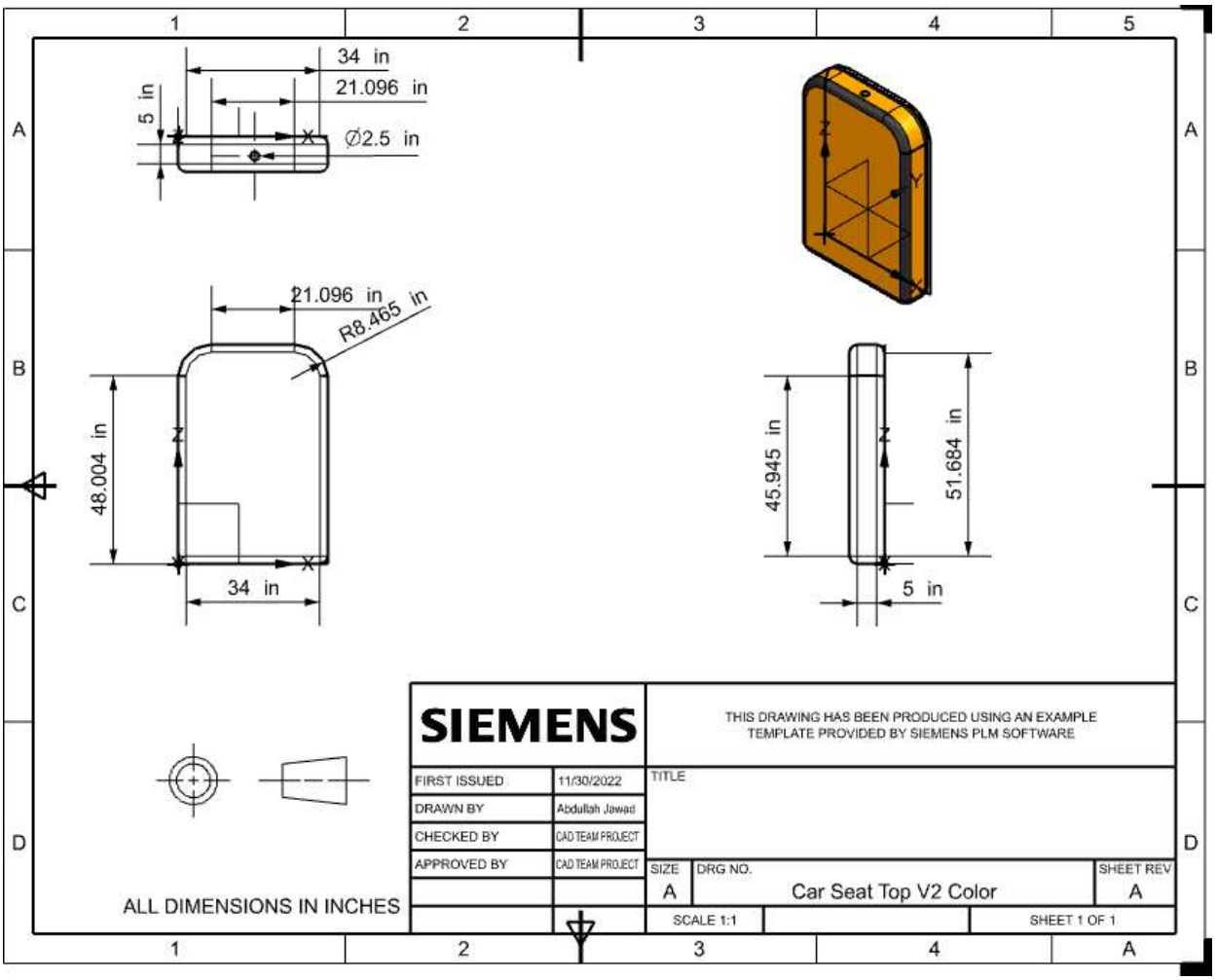

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SHEET 1 OF 1
ALL DIMENSIONS IN INCHES

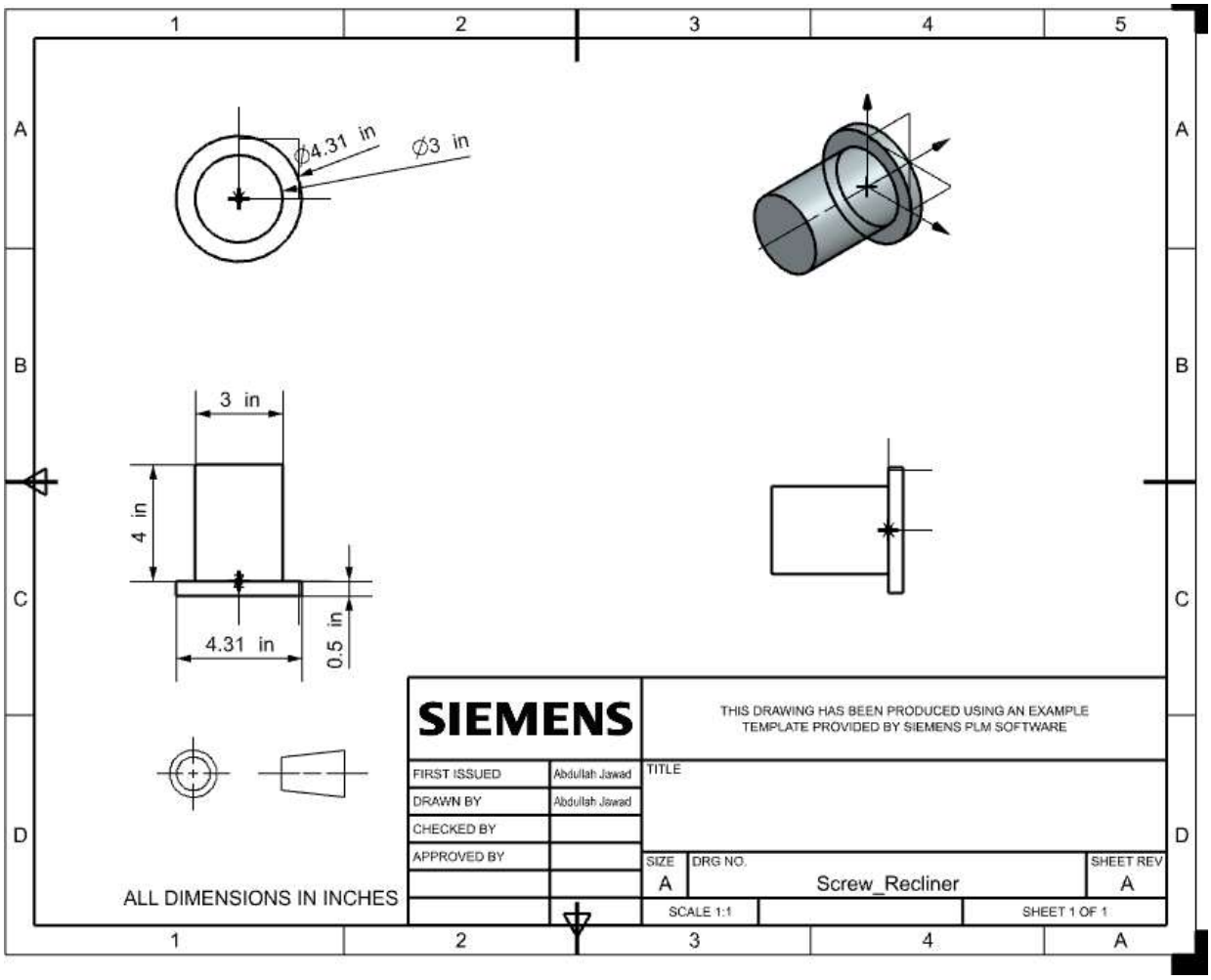

1.5 in
Ø1 in
Ø1 in
40 in
2.5 in
1.5 in
1.23 in
0.654 in
0.97 in
1.867 in
0.905 in
0.3 in
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED Abdullah Jawad
DRAWN BY Abdullah Jawad
CHECKED BY CAD PROJECT TEAM
APPROVED BY CAD PROJECT TEAM
TITLE
SIZE A
DRG NO. model2_dwg1
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


Ø2 in
2 in
0.1 in
0.4 in
3.5 in
Ø1.2 in
SIEMENS
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TITLE
SIZE A
DRG NO. Screw_gear
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES

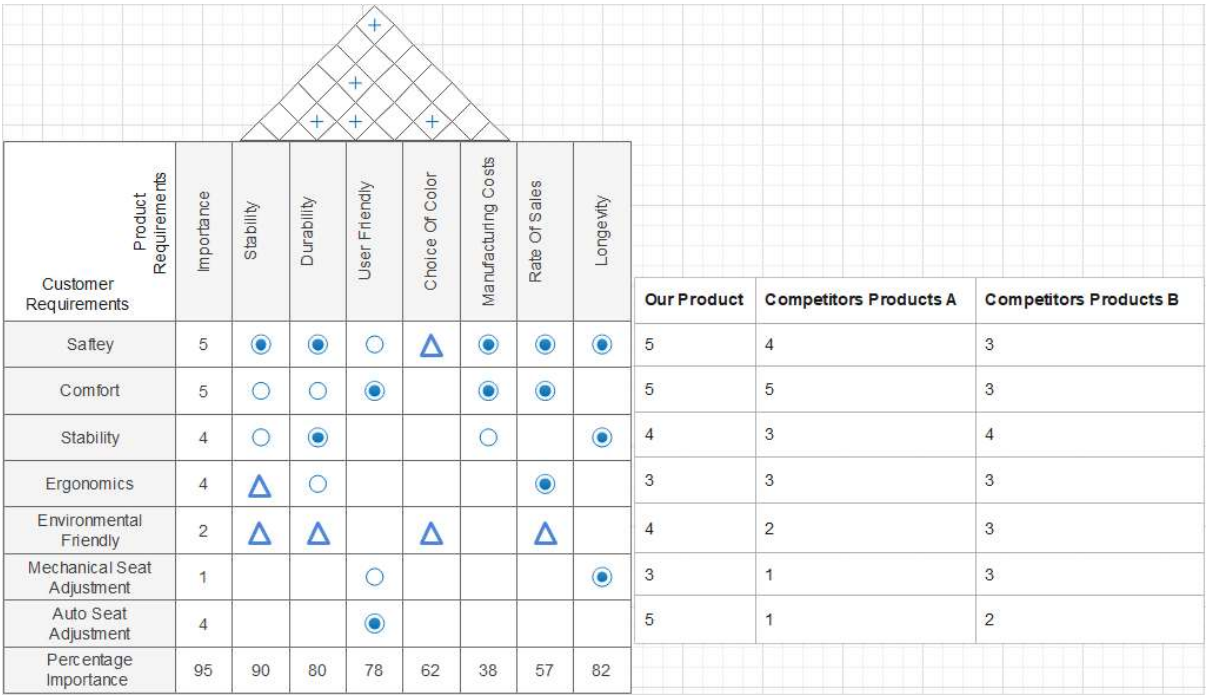

Ø1 in
Ø1.08 in
1 in
1.13 in
0.1 in
1.08 in
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
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DRAWN BY Abdullah Jawad
CHECKED BY CAD PROJECT TEAM
APPROVED BY CAD PROJECT TEAM
TITLE
SIZE A
DRG NO. Case Screw
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


20.771 in
11.819 in
R2.033 in
5 in
Y
11.819 in
3.47 in
14.438 in
Z
2.124 in
4 in
2.5 in
20.771 in
25 in
5 in
Z
13 in
9 in
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED 11/30/2022
DRAWN BY Abdullah Jawad
CHECKED BY CAD PROJECT TEAM
APPROVED BY CAD PROJECT TEAM
TITLE
SIZE A
DRG NO. Car seat head
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


34 in
21.096 in
5 in
∅2.5 in
21.096 in
R8.465 in
48.004 in
34 in
45.945 in
51.684 in
5 in
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED 11/30/2022
DRAWN BY Abdullah Jawad
CHECKED BY CAD TEAM PROJECT
APPROVED BY CAD TEAM PROJECT
TITLE
SIZE A
DRG NO. Car Seat Top V2 Color
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


1
2
3
4
5
A
B
C
D
ϕ4.31 in
ϕ3 in
3 in
4 in
4.31 in
0.5 in
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED
Abdullah Jawad
DRAWN BY
Abdullah Jawad
CHECKED BY
APPROVED BY
TITLE
SIZE
A
DRG NO.
Screw_Recliner
SHEET REV
A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES

Appendix H: House of Quality Matrix



Product Requirements / Customer Requirements	Importance	Stability	Durability	User Friendly	Choice Of Color	Manufacturing Costs	Rate Of Sales	Longevity	Our Product	Competitors Products A	Competitors Products B
Saftey	5	◉	◉	○	△	◉	◉	◉	5	4	3
Comfort	5	○	○	◉		◉	◉		5	5	3
Stability	4	○	◉			○		◉	4	3	4
Ergonomics	4	△	○				◉		3	3	3
Environmental Friendly	2	△	△		△		△		4	2	3
Mechanical Seat Adjustment	1			○				◉	3	1	3
Auto Seat Adjustment	4			◉					5	1	2
Percentage Importance	95	90	80	78	62	38	57	82			

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