Engineering Design and Graphics 1C03

McMaster Engineering 1 Cornerstone Project

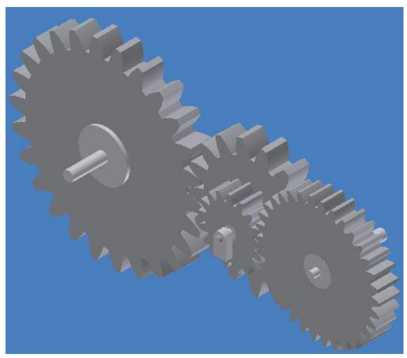
Instructor: Dr. Doyle

Group 93

Yosef Kelly 1151293

Benjamin Pister 1132694

Tom Woudenberg 1140006



As a future member of the engineering profession, the student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University and the Code of Conduct of the Professional Engineers of Ontario Submitted by

Yosef Kelly, 1151293____

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Benjamin Pister, 1132694____

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Thomas Woudenberg, 1140006____

Table of Contents

The purpose of this project was to design a gear train to operate the read head of a CD ROM drive. Through knowledge in Autodesk and MapleSim, we were able to design a model of a functional CD ROM drive read head. The gear train would run from the motor, through the chassis and connect to the read head to allow linear motion of the read head. Through proper methods of calculations and manipulation of the overall design, we were able to achieve exactly what our client has asked from us. The following report will describe and give a representation of the overall design process and final design.

For our gear train, we wanted to take the simplest approach so as not to cause complications, and so if corrections were needed to be made, they could be done without changing a huge gear train. Our gear train consists of 2 spur gear pairs 2 worm-gear pairs and 1 worm-rack pair. The reason for the 2 spur gear pairs is to increase the rotational speed. All of our worms have only 1 tooth and so every worm-gear pair has a great decrease in rotational speed due to the large gear ratio between the worm gear and the worm. To get to our final rotational speed of the read head, we needed to use the 2 spur gear pairs to increase the speed from our input rotational velocity. The purpose of the two worm-gear pairs is to turn the gear train 90 degrees due to the shape of the chassis. The two worm gears are connected by a rotating rod (more practical than having spur gear pairs all the way through the chassis). Finally the worm-rack pair was used to connect to the read head which gave linear motion to the read head thus allowing it to function. As one can see, a very simplistic approach to a gear train in a CD ROM drive, however quite practical.

Overall, each team member contributed to each part of the project. When our team had our meetings we worked on all aspects of the project at the same time, helping one another to better understand all aspects of the final design. Though each team member put effort into each part of the project, they also had leadership roles in certain aspects of the project. The following linear responsibility chart describes the above statement:

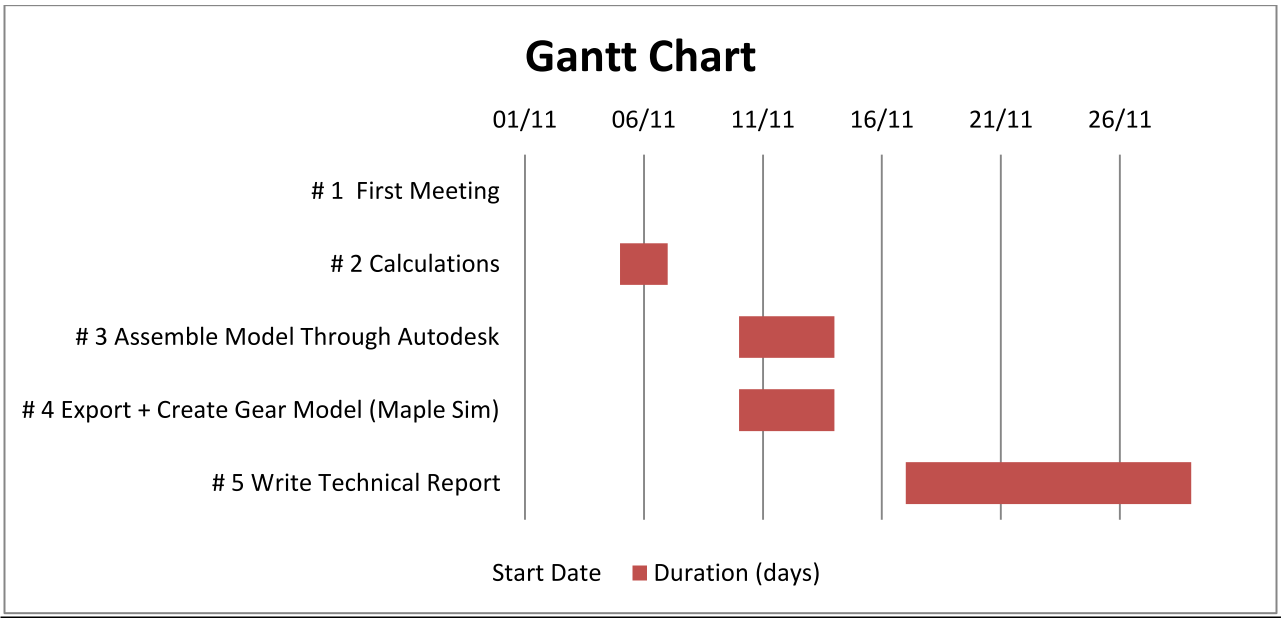
Section	Task	Yosef K.	Benjamin P.	Thomas W.
Conceptual Design	Schedule Meetings	1	1	1
	Review Requirements	1	1	1
Preliminary Design	Calculations	2	2	1
Detailed Design	AutoCAD Models	2	2	1
	MapleSim Modelling	1	2	2
Design Communication	Engineering Drawings	2	2	1
	Visual Representations (i.e. graphs)	2	1	2
	Technical Report	2	1	2

Note: Should work not be completed in meetings, the person with a '1' would be in charge of making sure it is fully finished, with the other members of the group, '2', looking over the work to make sure it is complete and correct.

Meeting Schedule

Meeting Type	Date of Meeting	Yosef Kelly	Benjamin Pister	Thomas Woudenberg
# 1)First Meeting	Nov. 3, 2011	P	P	P
#2)Calculations	Nov. 5, 2011	P	P	P
#3)Create Gear Parts	Nov. 10, 2011	P	P	P
#4)Assemble Model	Nov. 10, 2011	P	P	P
#5)Technical Report	Nov. 17, 2011	P	P	P

Note: 'P' stands for present and means the group member attended the group meeting.



Note: Task #1, which was our first meeting, occurred on Nov. 3 and ended on Nov. 3, hence there was no real duration or deadline of the first meeting. Also, the graph goes by intervals of 5 days beginning from Nov.1,2011. The whole project, including the technical report was completed on Nov. 29, 2011

Calculations:

The following information will describe in detail all the calculations that were used in this project. Our purpose for showing these calculations is to demonstrate our knowledge in gear trains as well as allow the viewer to fully understand our gear train design. The calculations are written out below in the order that we did our calculations during the preliminary design.

1) Calculated the Input speed (in RPM) from project outline and converted it to revolutions per second:

$$Input\ RPM = 93\ \times 850 = \frac{79050\ rev}{min} 79050 \div 60 = 1317.5\ rev/second$$

2) Converted output from m/s to mm/s to correspond to input speed (RPS):

$$Output\ \left(\frac{mm}{s}\right) = 0.125\frac{m}{s} \times 1000 = 125\frac{mm}{s}$$

3) Wanted module of final worm to be approximately one, so calculated the Gear Ratio according to this requirement:

$$Output\ \left(\frac{rev}{second}\right) = 125\left(\frac{rev}{s}\right) = 125mm \times 1$$

$$125\frac{rev}{s} = \frac{1317.5}{GR}$$

$$GR = \frac{1317.5}{125} = 10.54$$

4) Set our designed gear train to equal approximately a 10.54 gear ratio

$$GR = \frac{G2}{G1} \times 1 \times \frac{G4}{G3} \times \frac{WG1}{1} \times 1 \times \frac{WG2}{1} \times 1 \approx 10.54$$

4i) The requirements for the gears were set to the following:

$$Teeth > 10$$

$$Module\ > 0.25$$

4ii) Diameter of first 3 gears has to be smaller than 15mm since they will be surrounded with walls from the case which are 15mm apart:

$$Diameter\ G1, G2, G3\ < 15mm$$

5) Need to maximize Gear 1 and 2, since they are the only gears decreasing our gear ratio:

$$Diameter\ G1, G3 \rightarrow 15mm$$

$$\frac{15}{0.25} = 60\ teeth$$

6) Once simplifying the equation and putting in the previous constraint:

$$\frac{G2 \times G4 \times WG1 \times WG2}{60 \times 60} \approx 10.54$$

7) The smallest gears we could put with the worms was 10 teeth. Both were set to the same value to simplify manufacturing process:

$$\frac{G2 \times G4 \times 10 \times 10}{60 \times 60} \approx 10.54$$

$$\frac{1}{36} \times G2 \times G4 \approx 10.54$$

8) Now we had to pick a value for Gear 2 and 4 which had to be large enough to not have a factor of 5 and equal a gear ratio of about 10.54. Also both gears should have the same number of teeth in order to simplify manufacturing.

We picked the lowest factor of 10 possible, so 20 teeth:

$$G2 = G4 = 20\ teeth$$

9) Now we determined the Gear ratio again according to these new gears:

$$\frac{20 \times 20 \times 10 \times 10}{60 \times 60} = 11.11111 \cong 10.54$$

10) We recalculated the output rev/s with the new gear ratio:

$$\frac{1317.5}{11.11111} = 118.575 \frac{rev}{s} \cong 125 \frac{rev}{s}$$

11) Then the required pitch of the final worm was calculated with the new output rotational speed:

$$\frac{125}{118.575} = 1.054185115\ mm \cong 1\ mm$$

12) We final set the pitch of every worm to the same size, so you could just make one worm during manufacturing and cut that to the desired lengths:

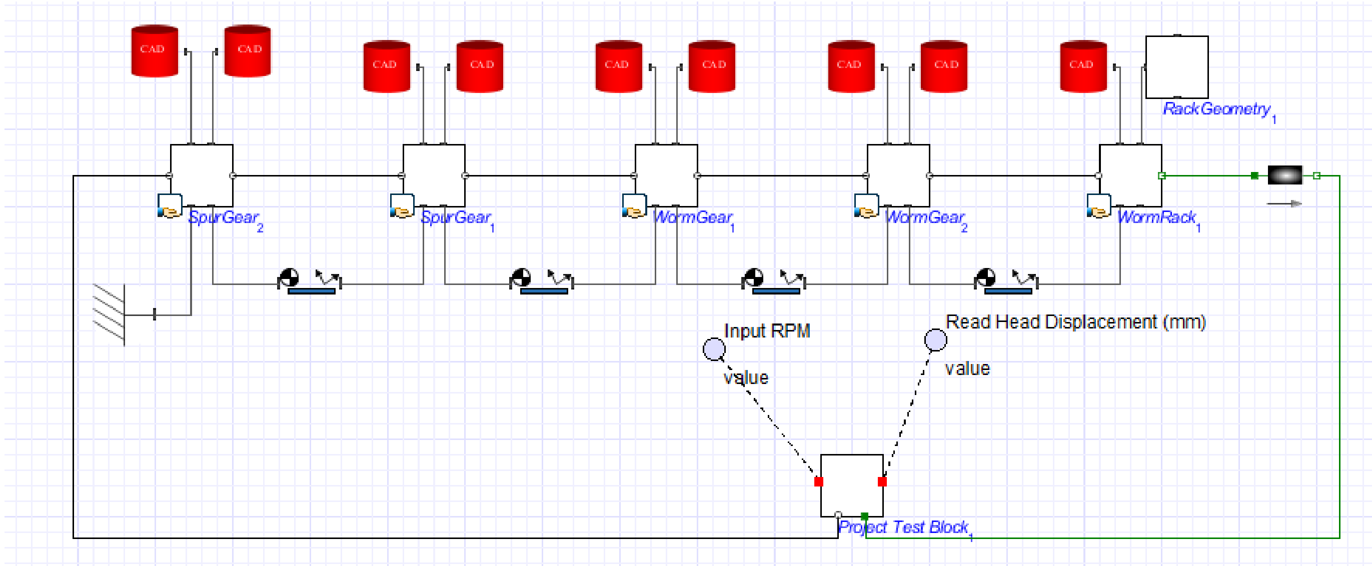
$$Worm\ 1{,}2{,}3 = 1.054185115\ mm$$

Final results

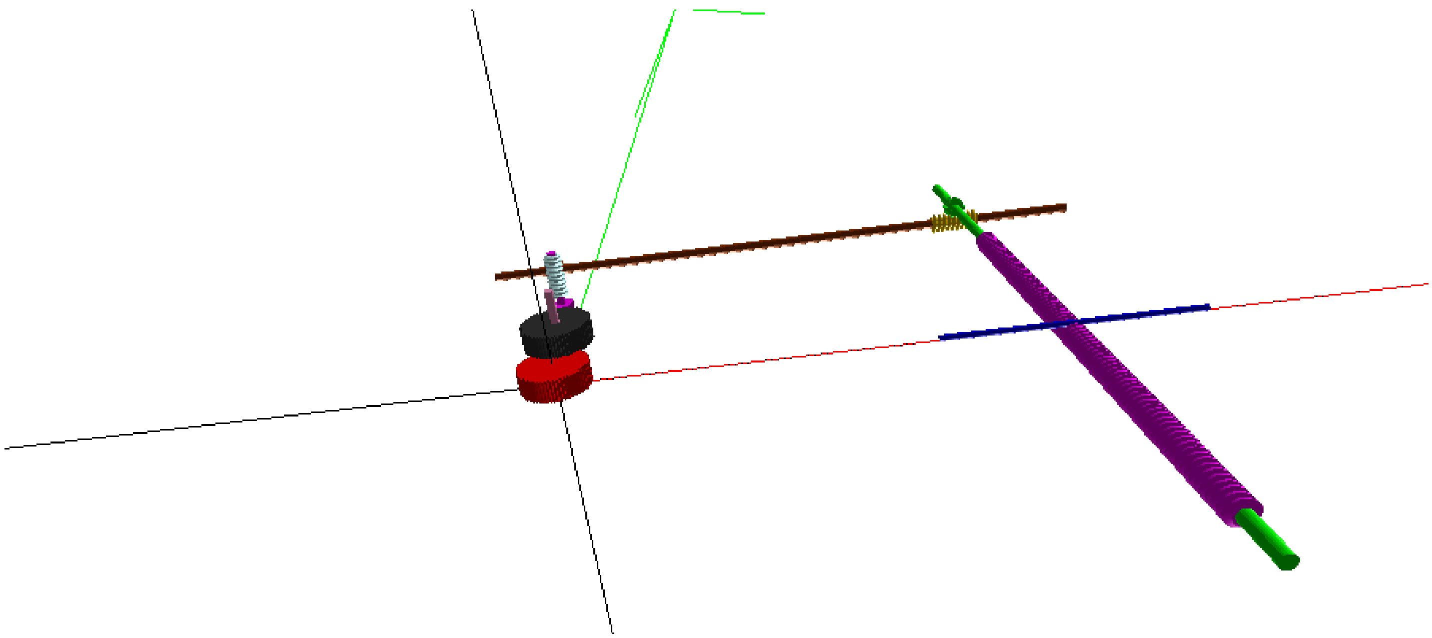
GR=11.111111

Gear 1 & 3 = 60 teeth	Module = 0.25	Diameter = 15 mm
Gear 2 & 4 = 20 teeth	Module = 0.25	Diameter = 5 mm
Worm Gear 1 & 2 = 10	Pitch = 1.054185115	

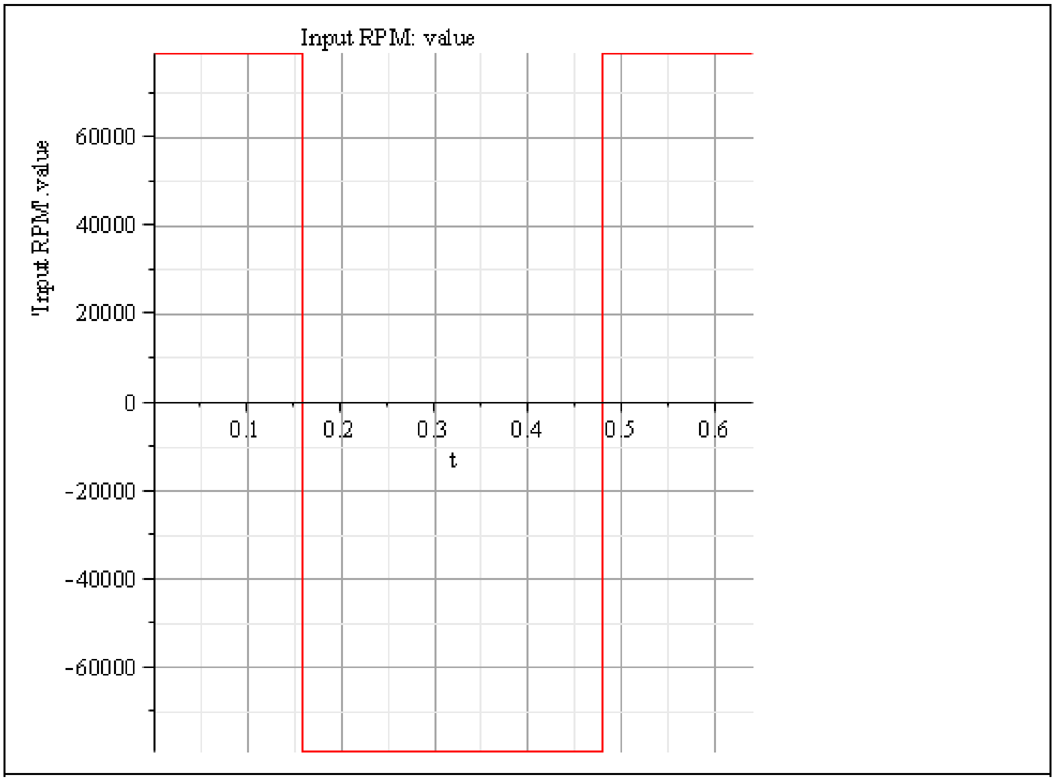
2D Schematic View

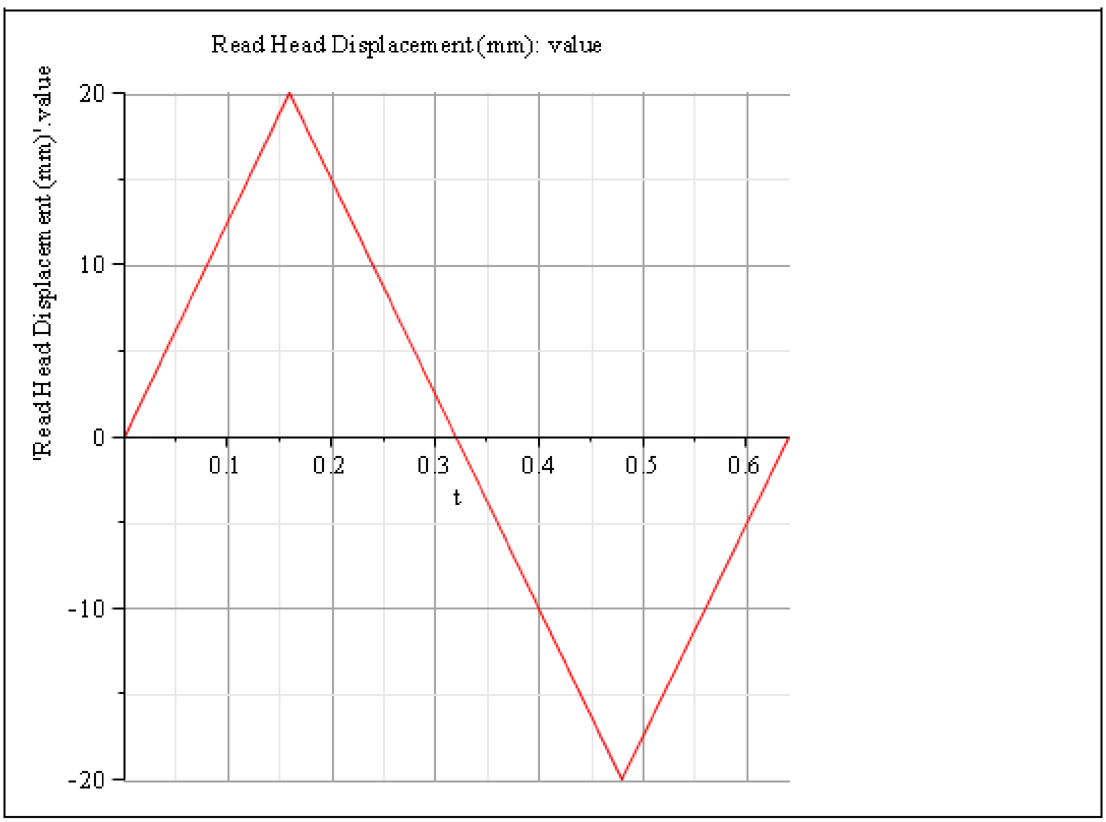


3D View

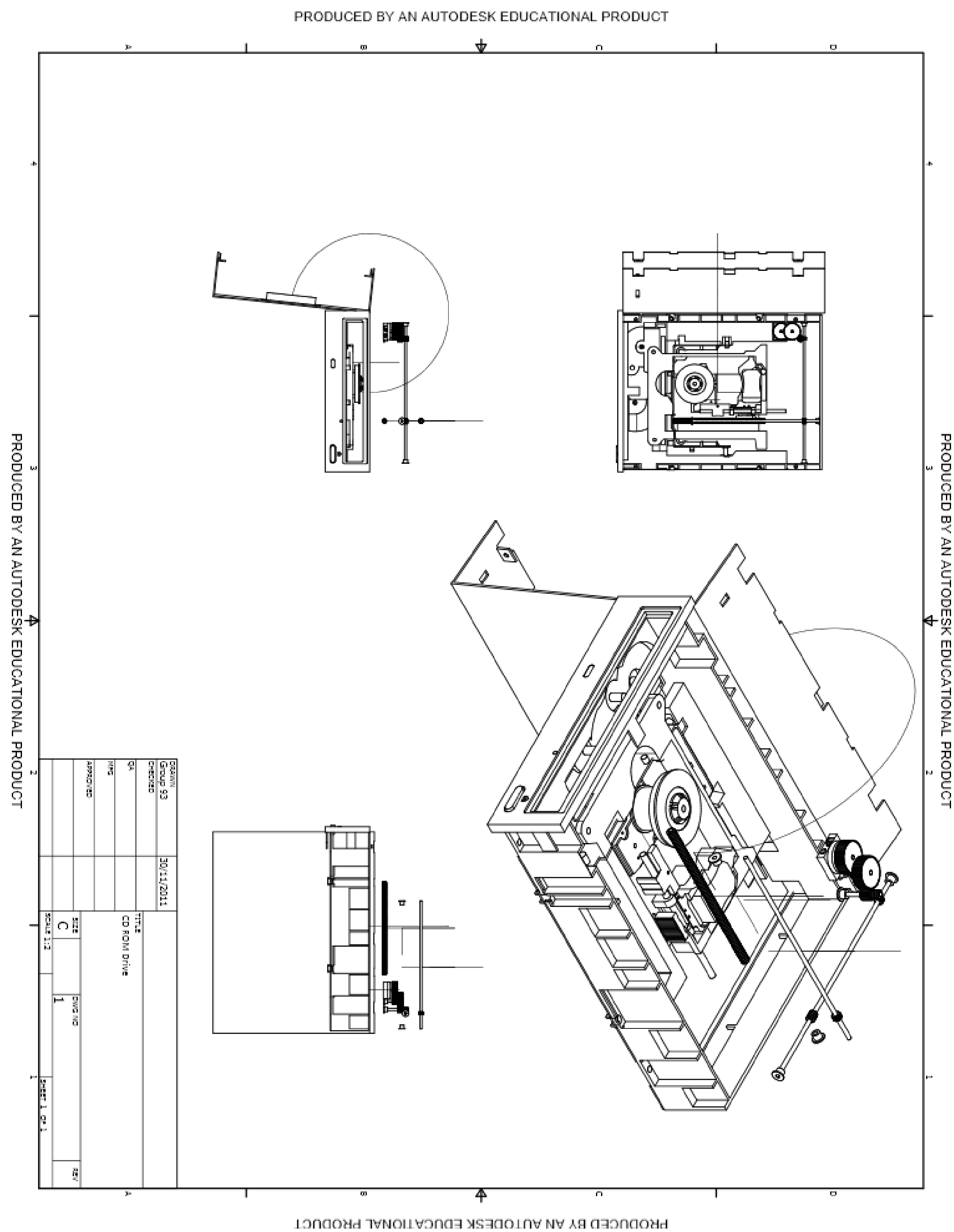


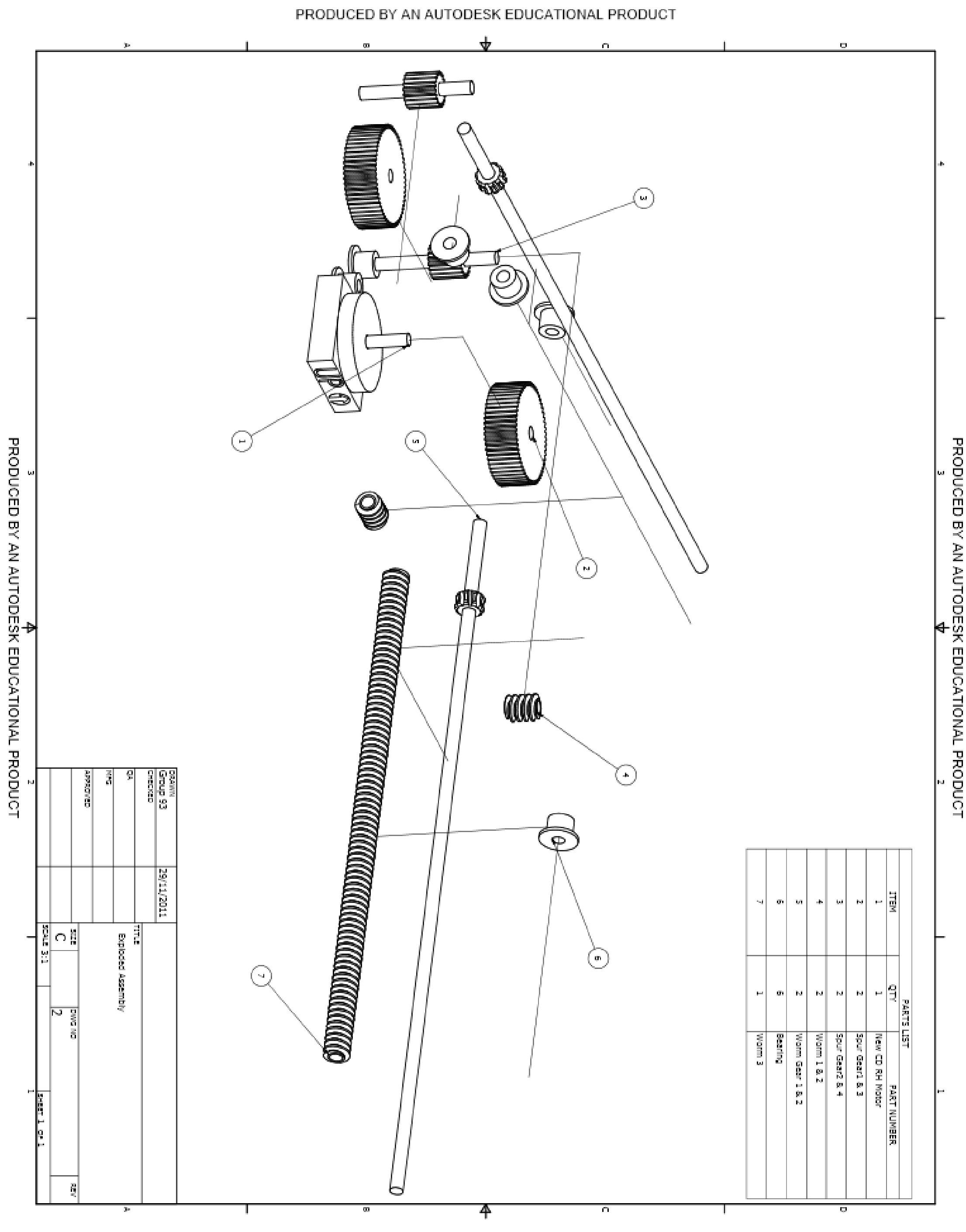
Probe Graphs





Engineering Drawings

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ITEM
QTY
PART NUMBER
1
1
New CD RH Motor
2
2
Spur Gear1 & 3
3
2
Spur Gear2 & 4
4
2
Worm 1 & 2
5
2
Worm Gear 1 & 2
6
6
Bearing
7
1
Worm 3
DRAWN
Group 93
29/11/2011
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APPROVED
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Exploded Assembly
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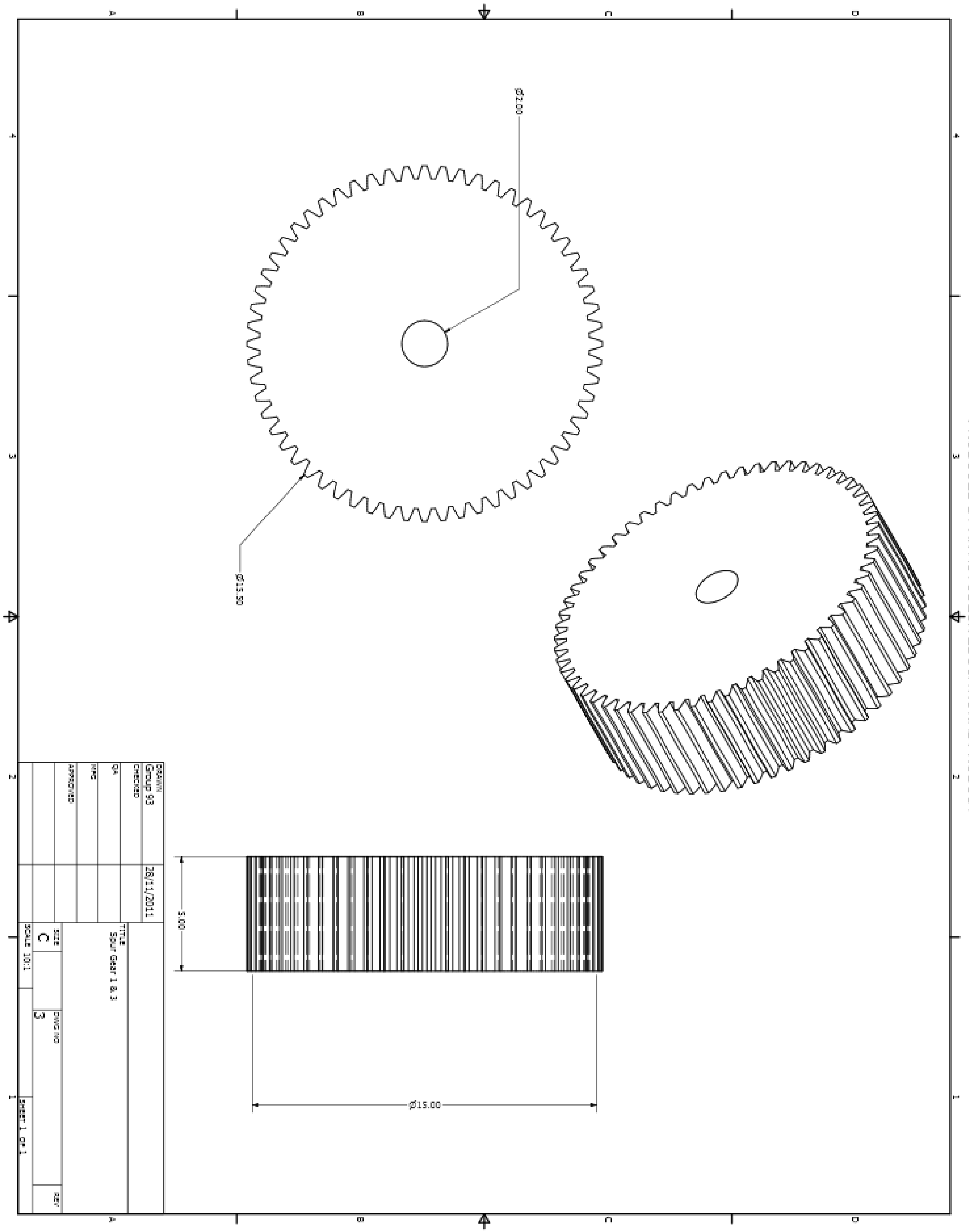

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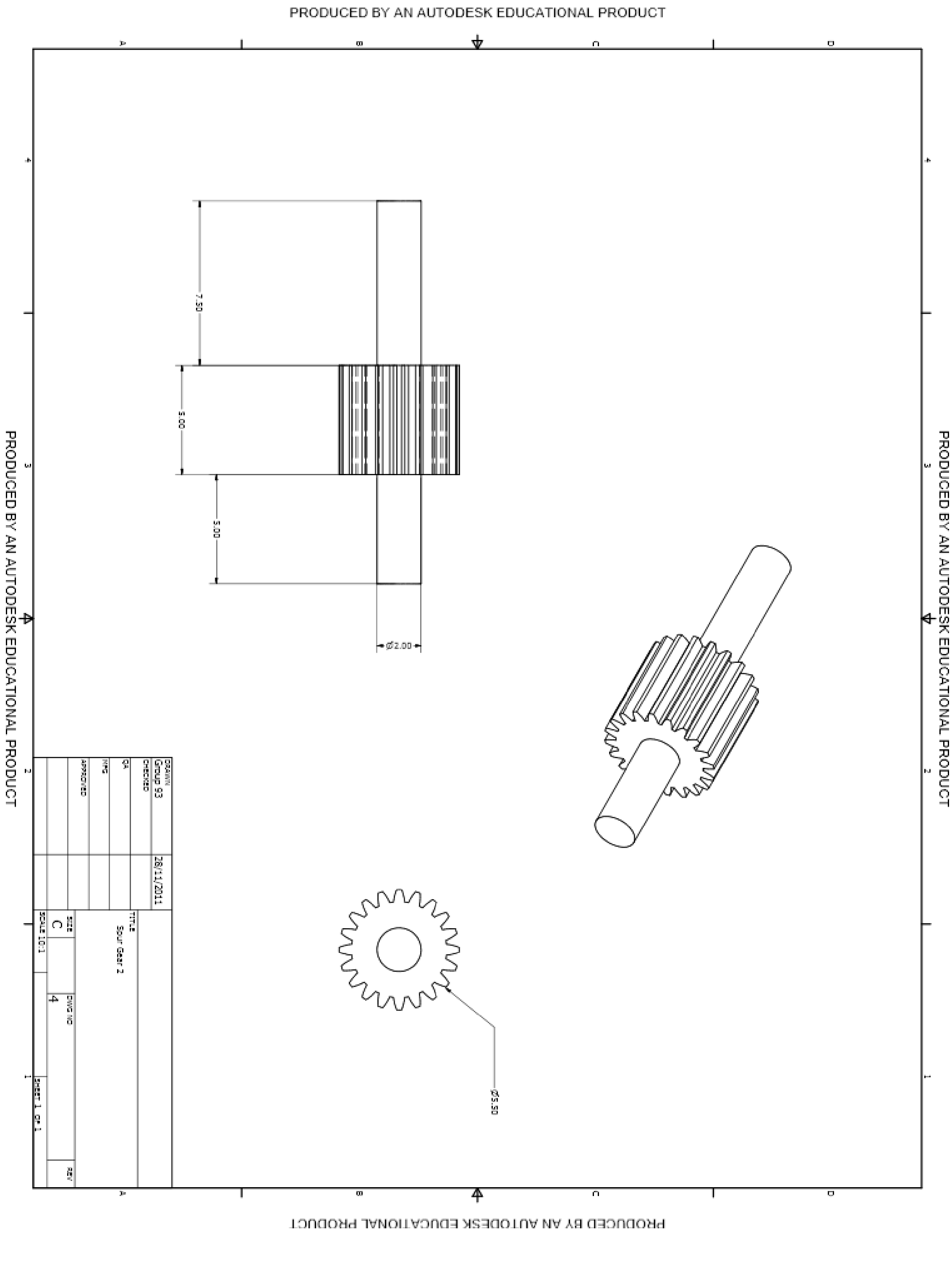
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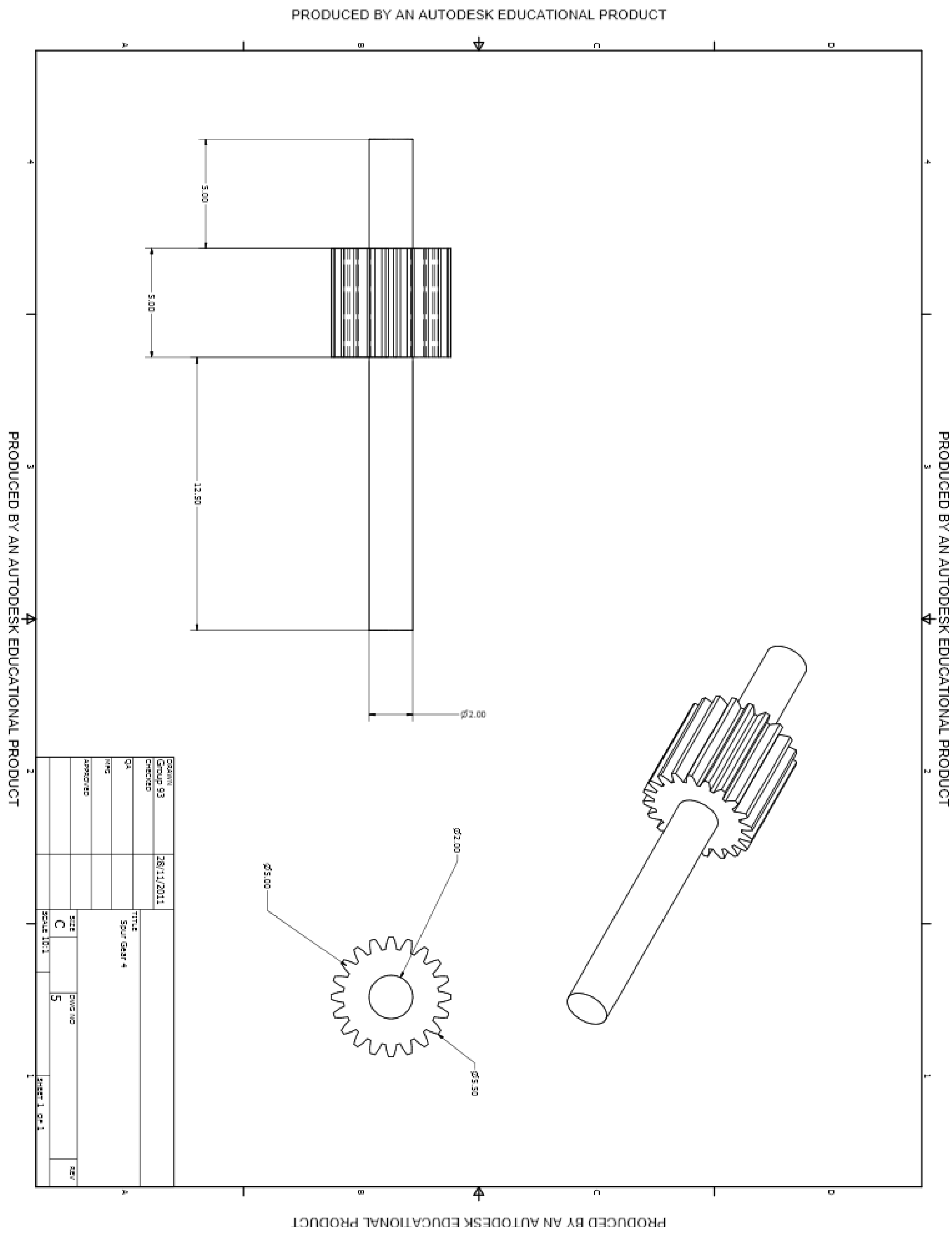
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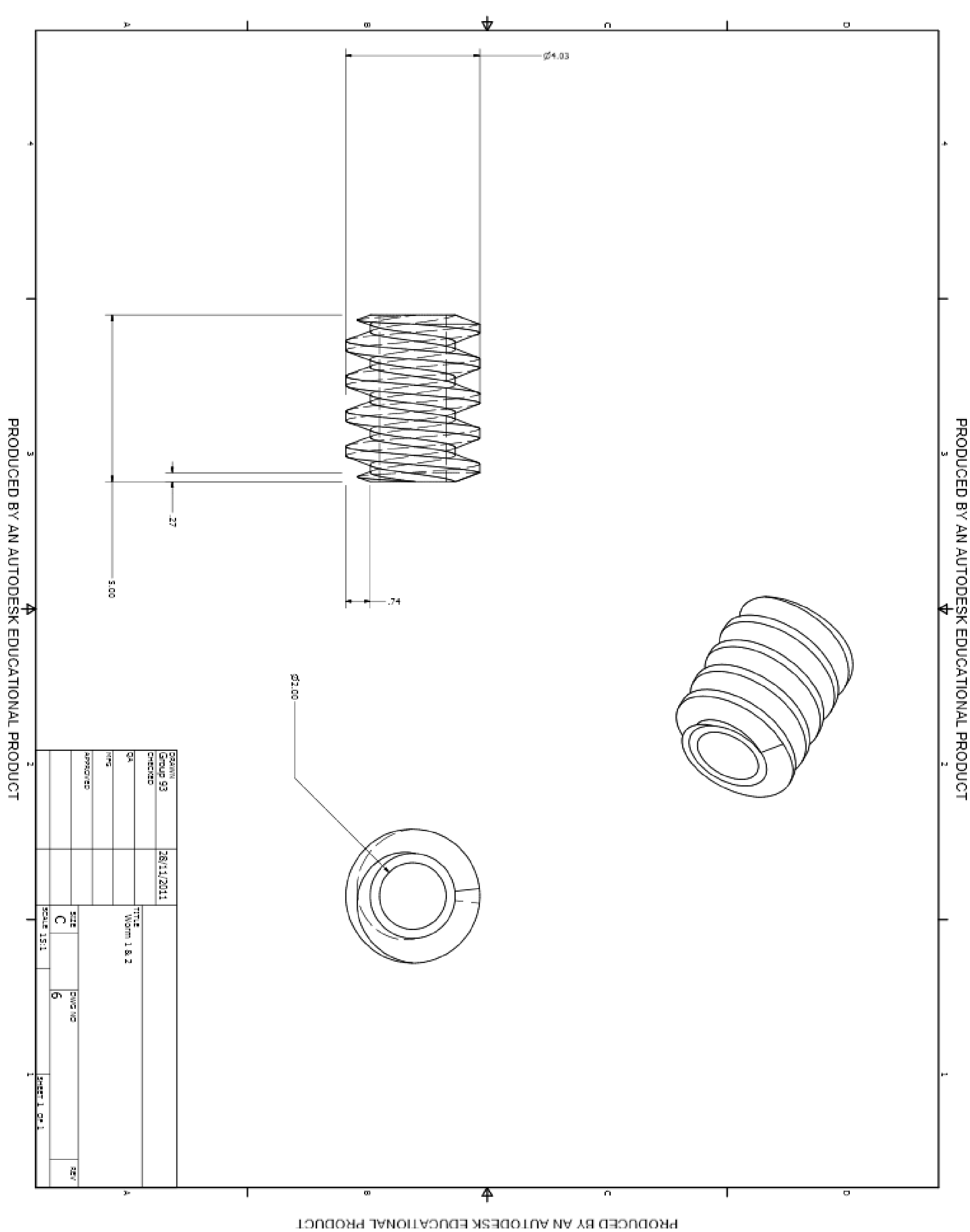
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Group 93
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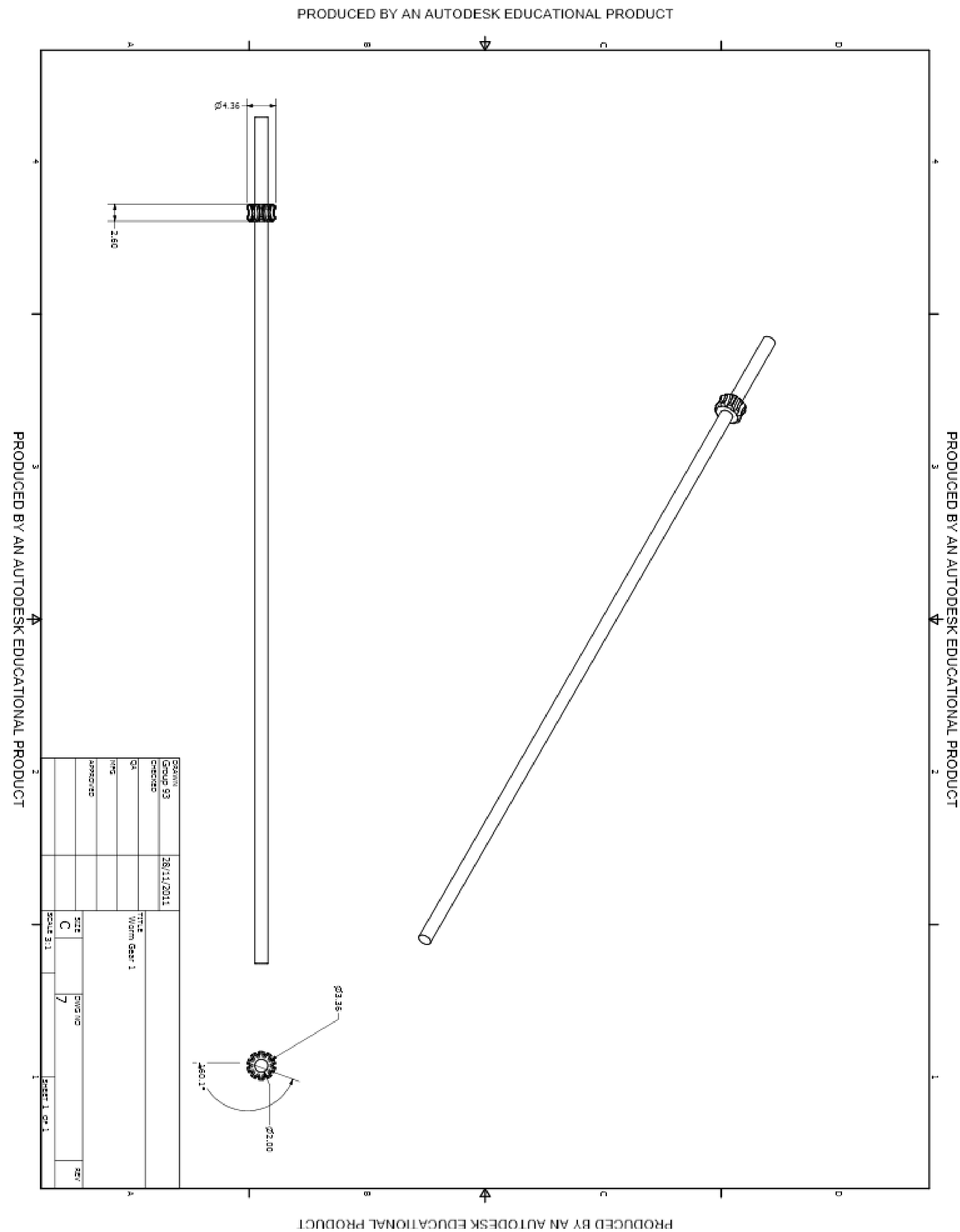

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Ø4.36
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Ø3.36
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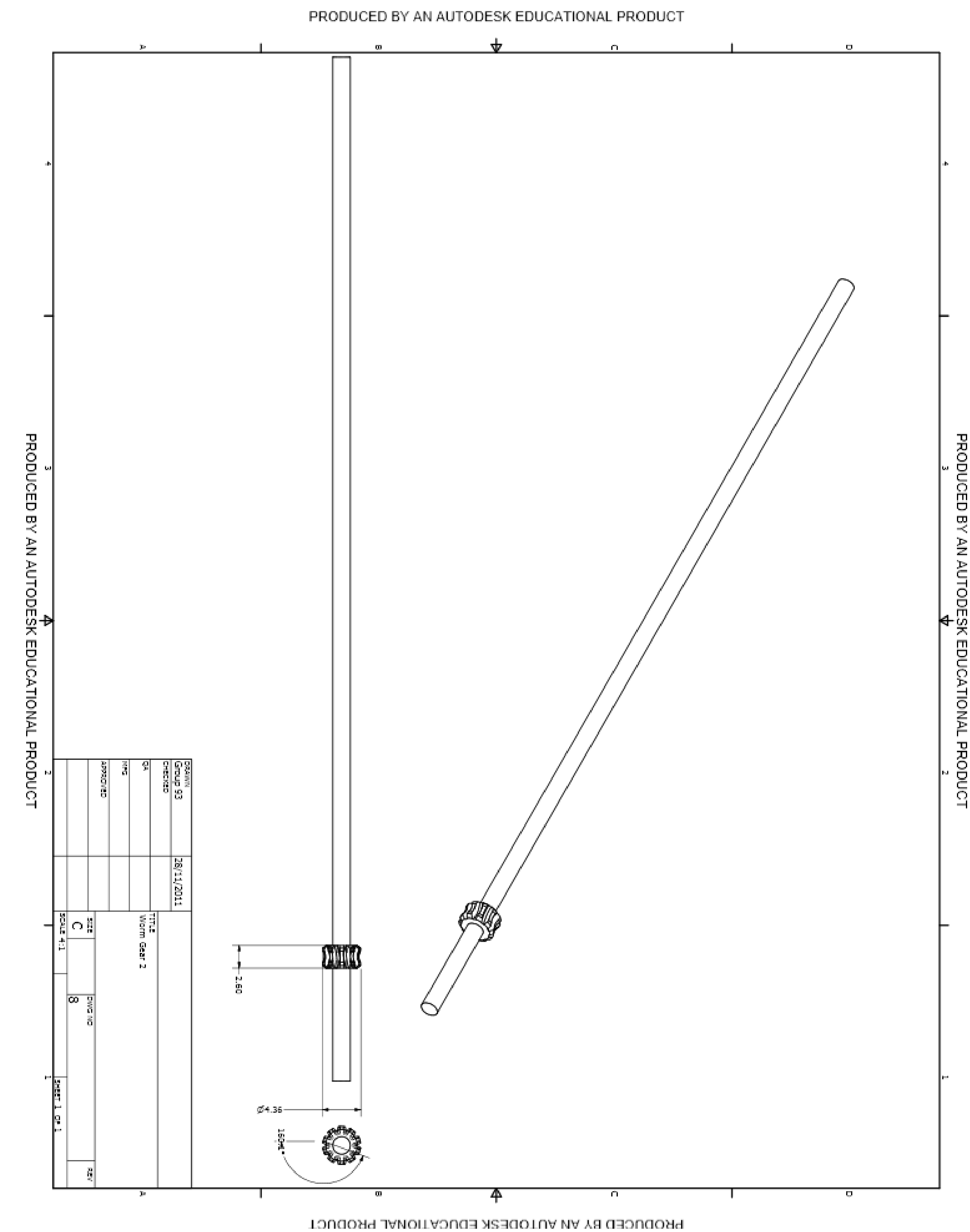
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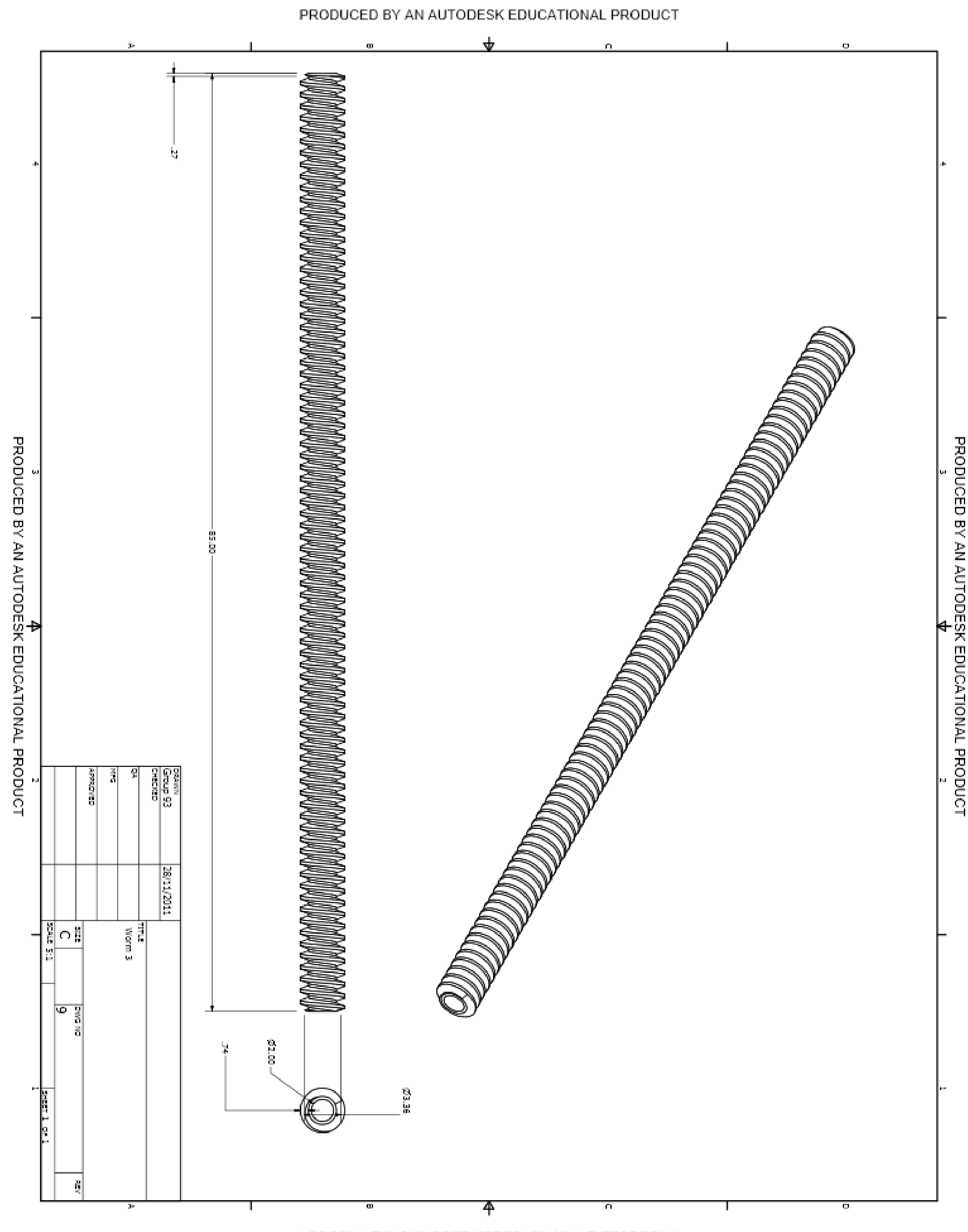
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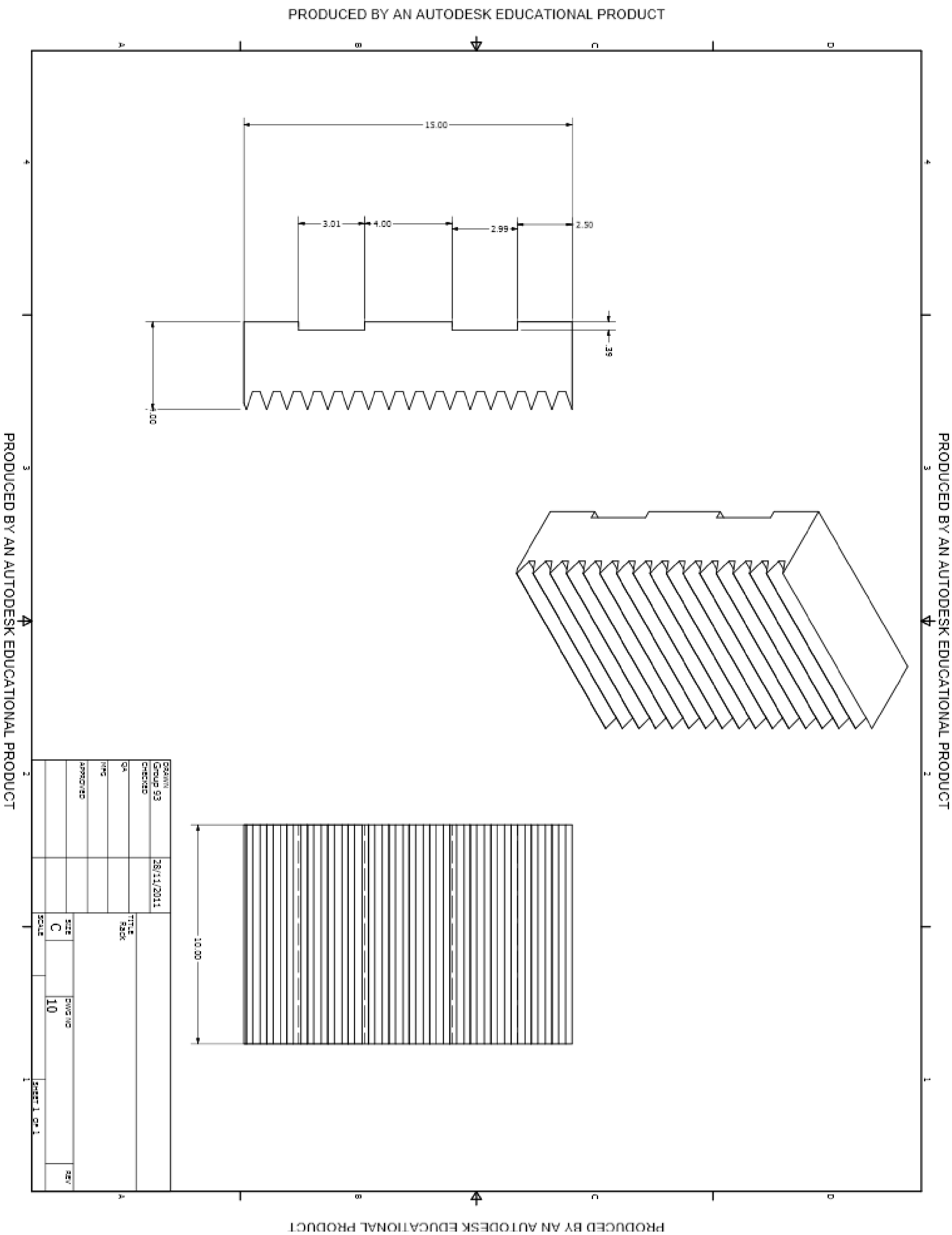
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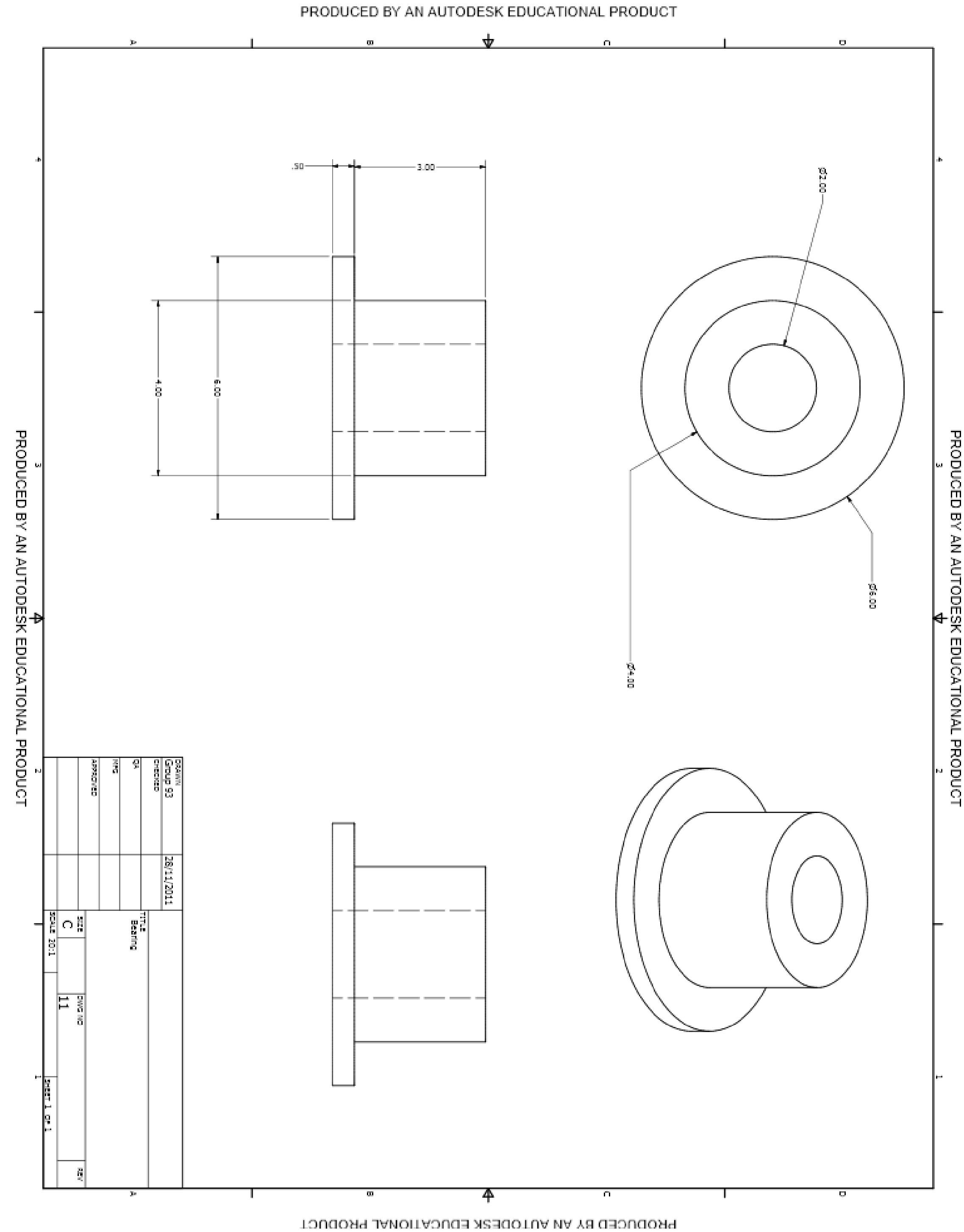
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