

Program: Mechanical Engineering

Course Number	MEC 816
Section Number	
Course Title	Topics in Manufacturing Engineering
Semester/Year	Winter 2021

Instructor	Dr. Ghasempoor
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Report No.	2
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Assignment Title	Group Project Milestone 2
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Submission Date	April 8th, 2021
Due Date	April 8th, 2021

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(Note: Remove the first 4 digits from your student ID)

*By signing above you attest that you have contributed to this submission and confirm that all work you have contributed to this submission is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a “0” on the work, an “F” in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: <http://www.ryerson.ca/senate/policies/pol60.pdf>.

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1.0 Summary

Our team was tasked with researching the manufacturing process for a two-stage gearbox, and creating a solid model of the design. The assignment's main focus was on creating solid models for all custom parts, followed by the process plans needed to make those parts. This report contains the Bill of Materials analysis for our gearbox, the process plans for custom parts, a pdf copy of all solidworks drawings, as well as an assembly chart, and final thoughts and conclusions.

BOM analysis

Table 2.0: Description of each part, material choice, and reference process plan in appendix

Part	Description	Material	Quantity	Reference
Shaft 1	Custom milled shaft (5x200mm McMaster Carr steel bar)	303 Stainless Steel	1	Fig. 1
Shaft 2	Custom milled shaft (Cutoff 6x200mm McMaster Carr steel bar)	303 Stainless Steel	1	Fig. 2
Shaft 3	Custom milled shaft (Cutoff 6x200mm McMaster Carr steel bar)	303 Stainless Steel	1	Fig. 3
Plate	Machined retention plate	303 Stainless Steel	3	Fig. 4
Plate w/hole	Machined retention plate w/hole for shaft	303 Stainless Steel	3	Fig. 5
Gear 1	Mcmaster-Carr: 2664N335; 20 Degree pressure angle	Black Oxide 1045- Carbon Steel	2	Fig. 10
Gear 2	Mcmaster-Carr: 2664N431; 20 degree pressure angle	Black Oxide 1045- Carbon Steel	1	Fig. 9
Gear 3	Mcmaster-Carr: 2664N347; 20 degree pressure angle	Black Oxide 1045- Carbon Steel	1	Fig. 8
Ball Bearing	Mcmaster-Carr: 57155K465; Metal Flanged Ball Bearing (Small)	440C Stainless Steel	4	n/a
Ball Bearing	Mcmaster-Carr: 57155K477; Metal Flanged Ball Bearing (Large)	440C Stainless Steel	2	n/a
Hex Nut	Mcmaster-Carr: 90593A003; Medium Strength Steel Hex Nut, M4 x 0.7mm	Black Oxide Steel	6	n/a
Socket Head Screw	Mcmaster-Carr: 91290A041; Steel Socket Head Screw, M1.6 x 0.35 mm Thread, 8 mm Long	Black Oxide Alloy Steel	36	n/a

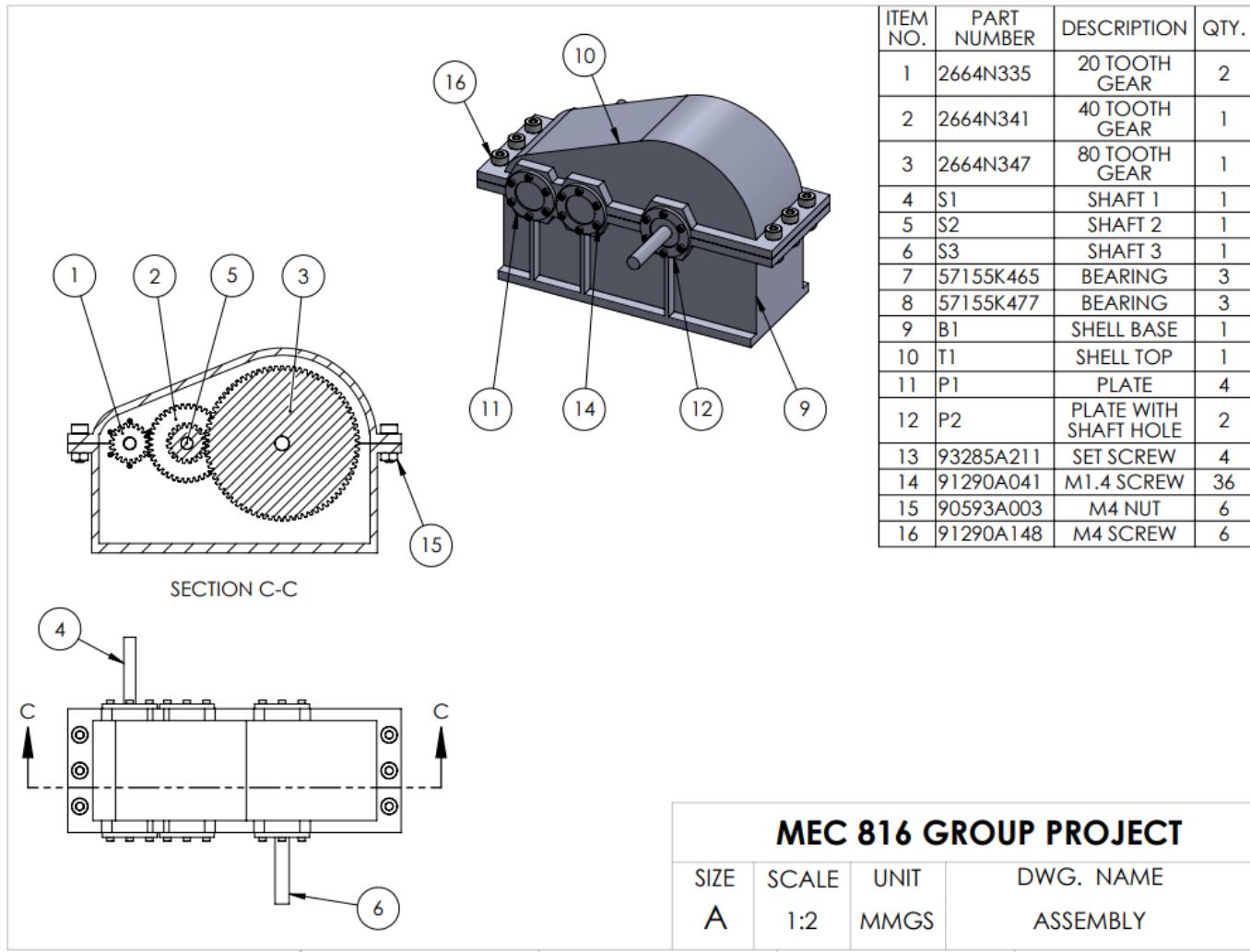
Socket Head Screw	Mcmaster-Carr: 91290A148; Black-Oxide Alloy Steel Socket Head Screw, M4 x 0.7 mm Thread, 12 mm Long	Black Oxide Alloy Steel	6	n/a
Nylon Tip Set Screw	Mcmaster-Carr: 93285A211; 18-8 Stainless Steel Nylon-Tip Set Screw, M4 x 0.7 mm Thread, 5 mm Long	18-8 Stainless Steel (Nylon Tip)	4	n/a
Shell Top	Custom made cast housing, top portion	CF-8 Steel	1	Fig. 6
Shell Base	Custom made cast housing, bottom portion	CF-8 Steel	1	Fig. 7

3.0 Conclusions and recommendations:

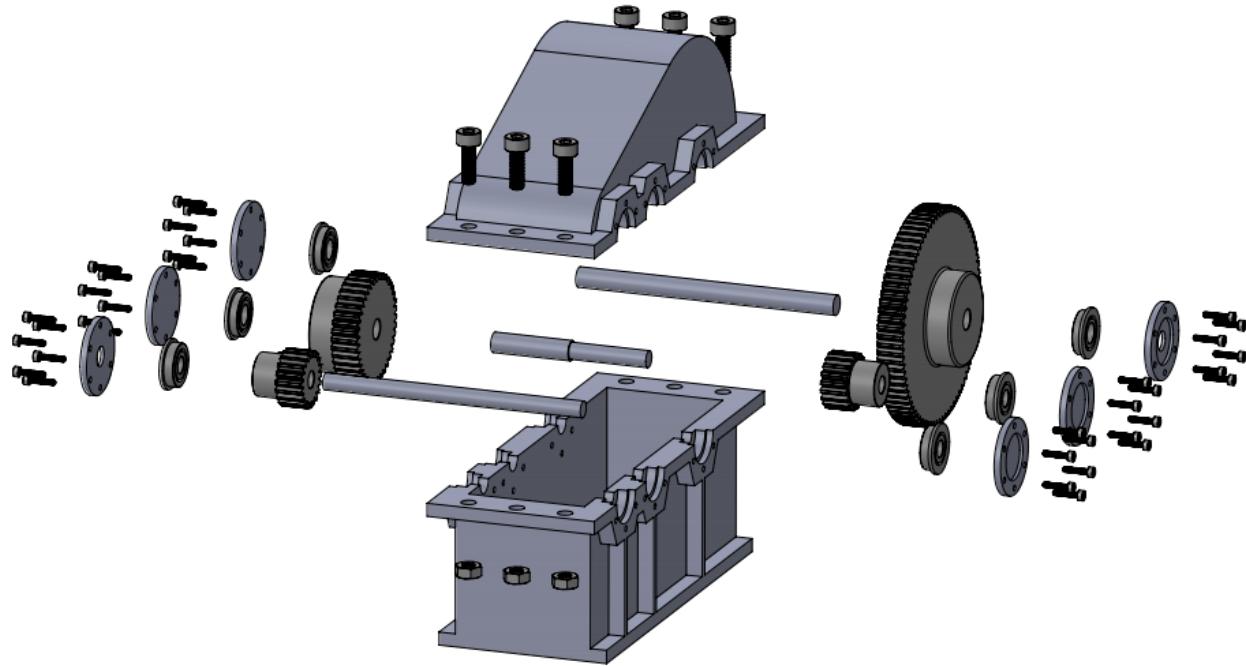
The prescribed task was to research the manufacturing processes required to create a two stage gearbox, then implement what was learned to create solid models of the gearbox and custom parts. Process plans were created for all custom machined and cast parts. An assembly chart was created to illustrate the order of assembly for the gearbox. Overall, the assignment was effective in providing specific examples of the level of detail needed for complete GD&T drawings, as well as the significance of these drawings. Creating process plans for parts provides experience that is applicable to real world solutions.

4.0 Appendix

4.1 Drawings



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MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:3	MMGS	EXPLODED VIEW

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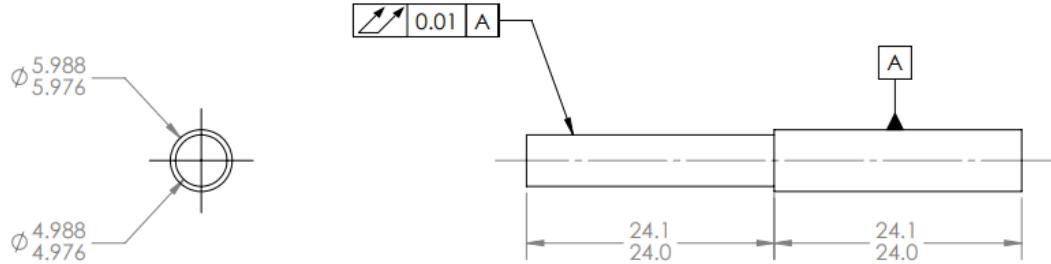
FINISHES

ASSUME 3.2RA ON ALL SURFACES
CORNER BREAK ALL EDGES AT 0.127MM

MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:1	MMGS	SHAFT 1

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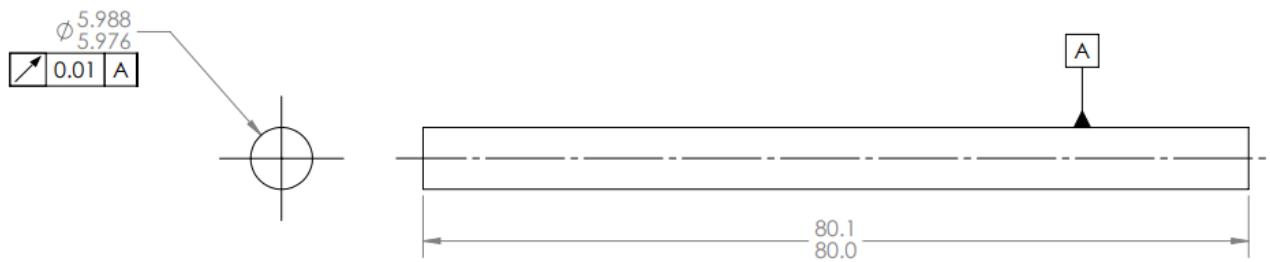


FINISHES

ASSUME 3.2RA ON ALL SURFACES
CORNER BREAK ALL EDGES AT 0.127MM

MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:1	MMGS	SHAFT 2



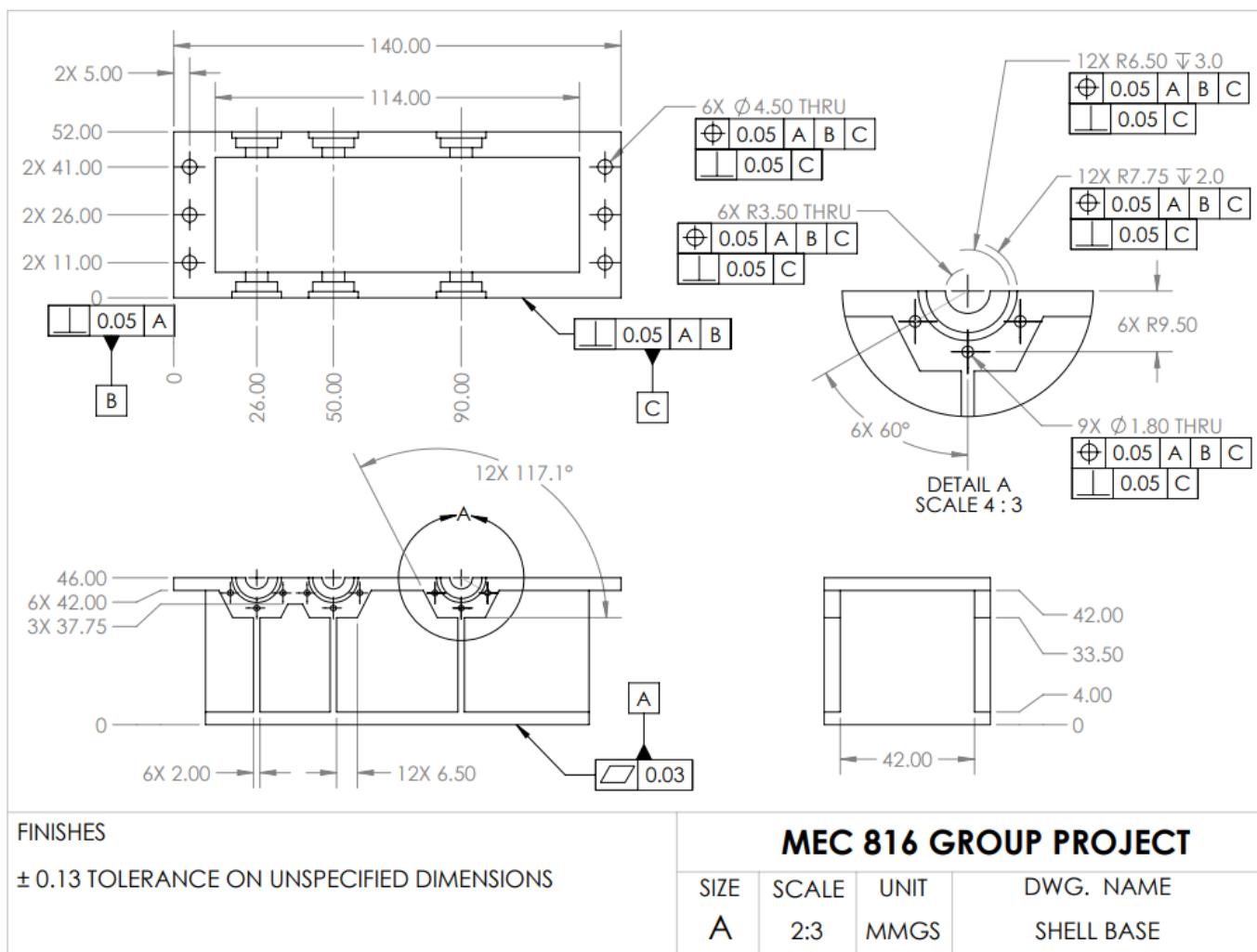
FINISHES

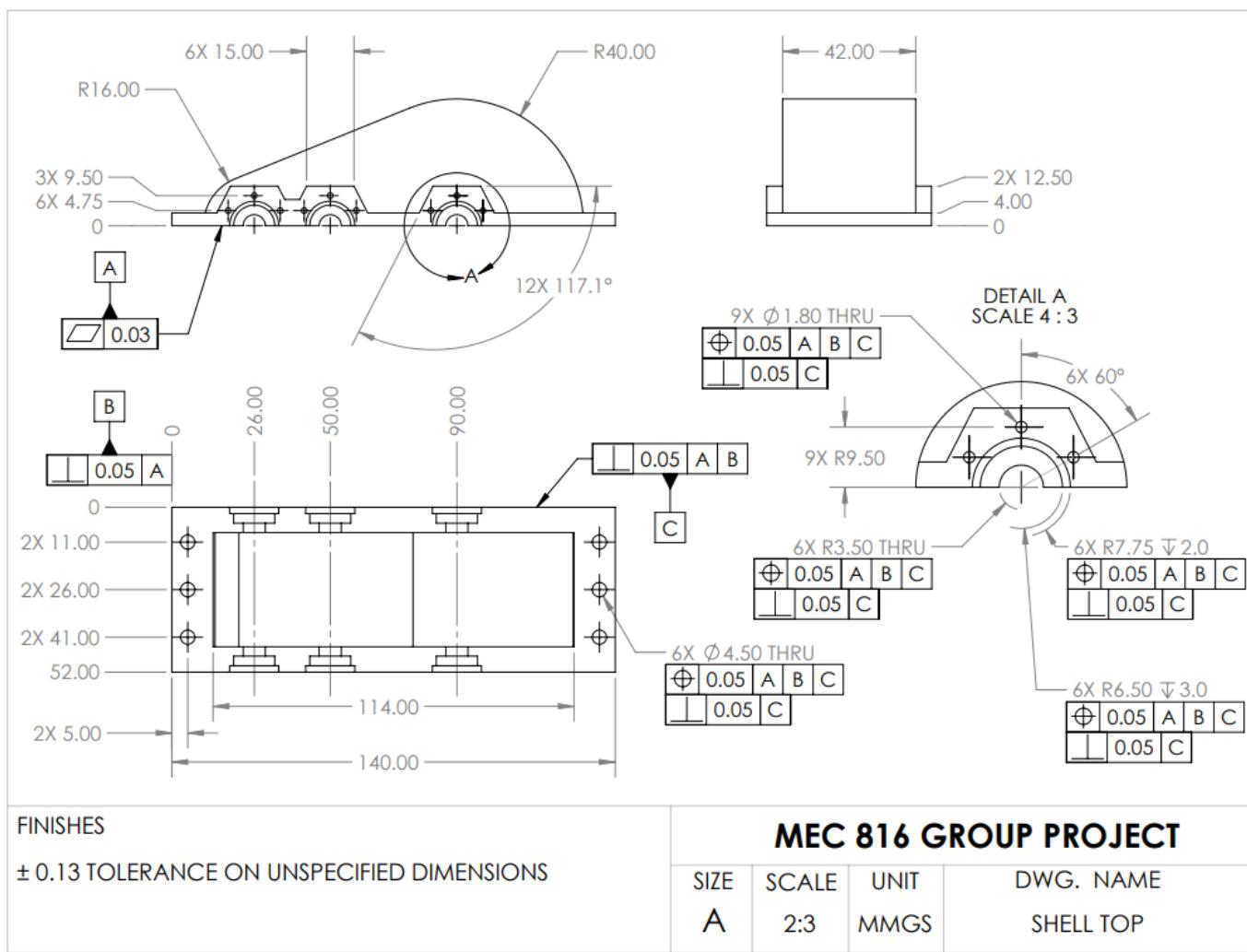
ASSUME 3.2RA ON ALL SURFACES
CORNER BREAK ALL EDGES AT 0.127MM

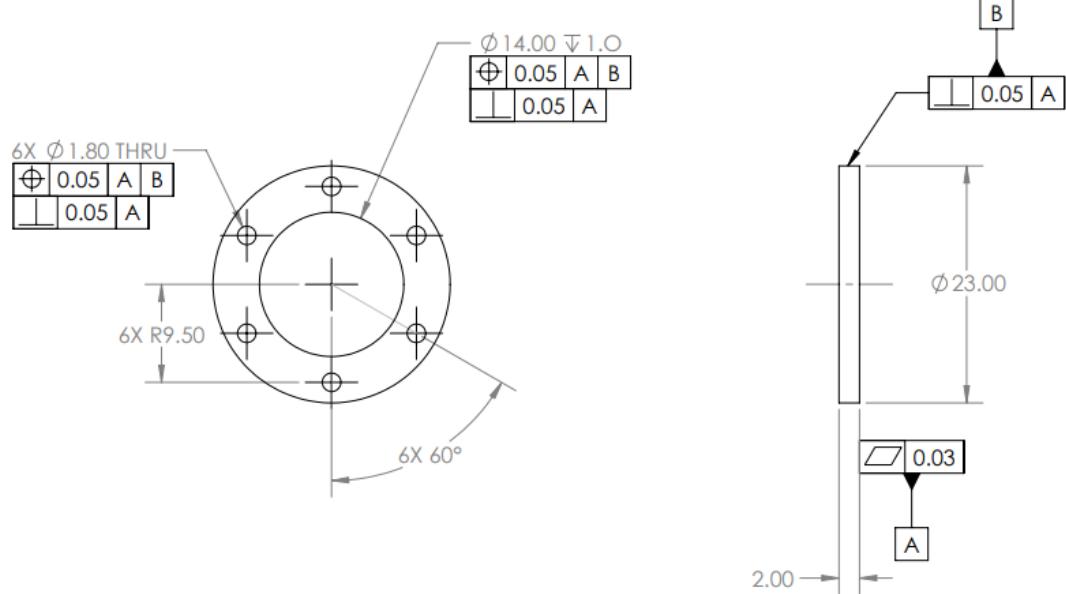
MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:1	MMGS	SHAFT 3

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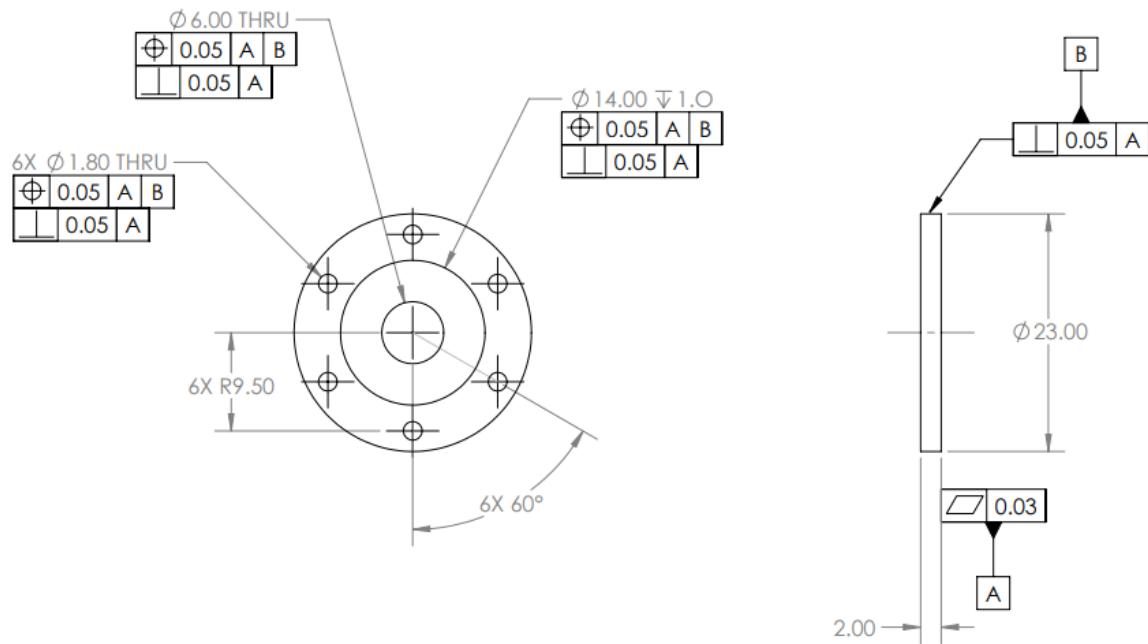
FINISHES

± 0.13 TOLERANCE ON UNSPECIFIED DIMENSIONS

MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:1	MMGS	PLATE

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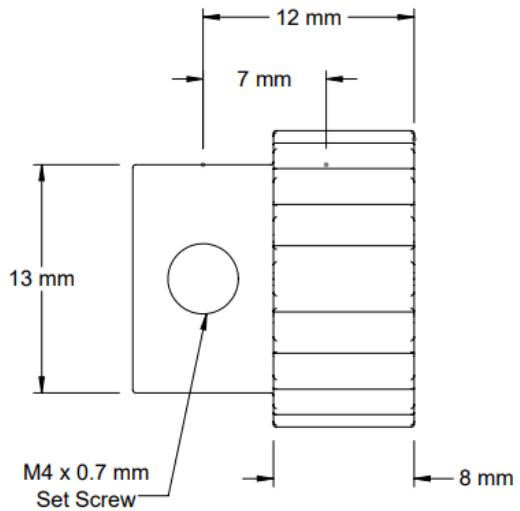
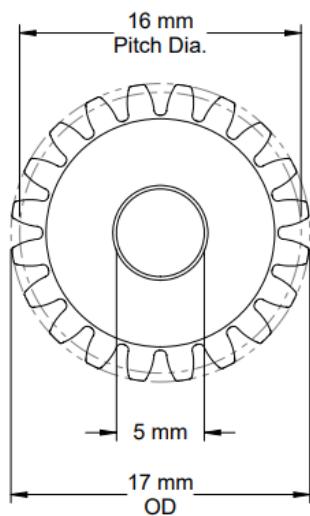
FINISHES

± 0.13 TOLERANCE ON UNSPECIFIED DIMENSIONS

MEC 816 GROUP PROJECT

SIZE	SCALE	UNIT	DWG. NAME
A	2:1	MMGS	PLATE WITH SHAFT HOLE

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Module: 0.8
Number of Teeth: 20

McMASTER-CARR CAD

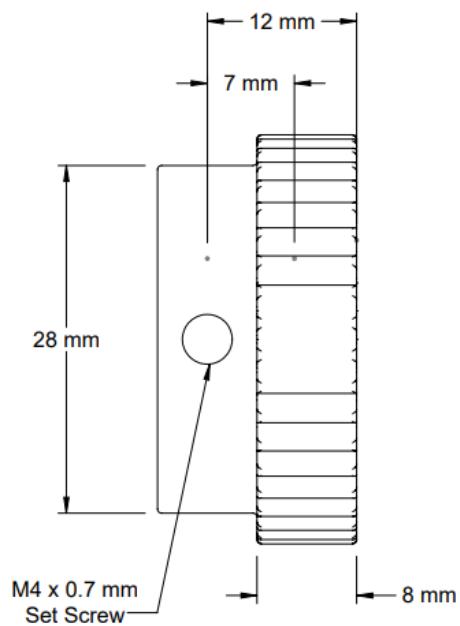
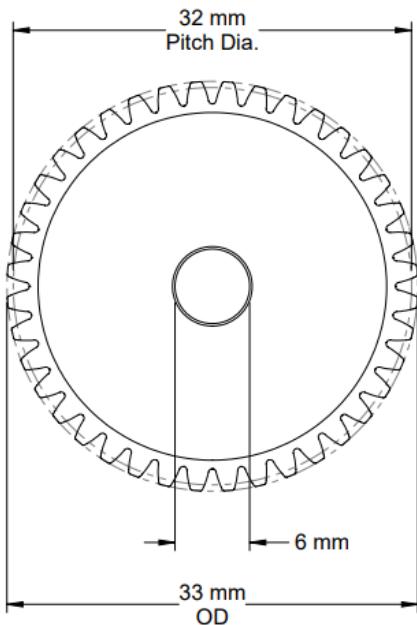
<http://www.mcmaster.com>
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PART
NUMBER

2664N335

Metal Gear - 20°
Pressure Angle

Information in this drawing is provided for reference only.



Module: 0.8
Number of Teeth: 40

McMASTER-CARR CAD

<http://www.mcmaster.com>

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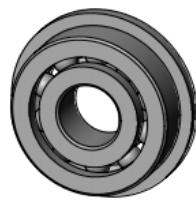
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PART
NUMBER

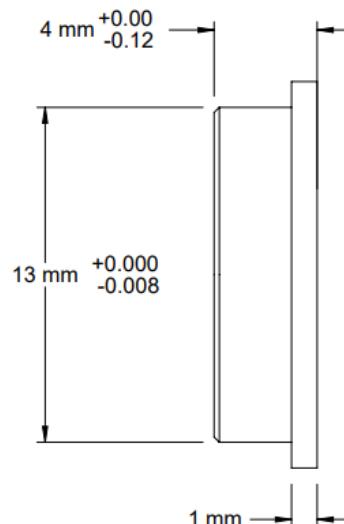
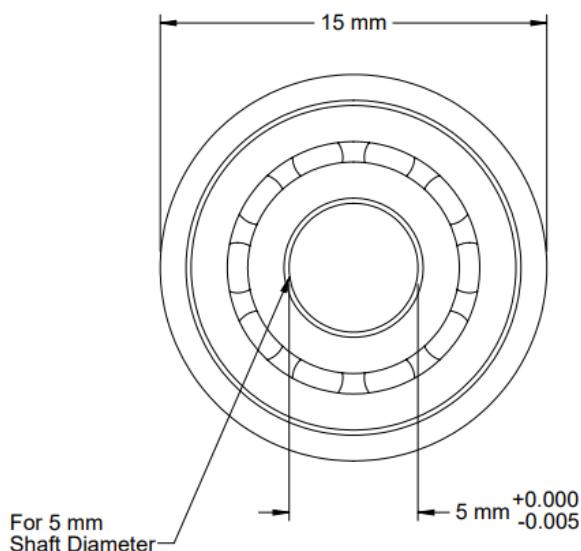
2664N341

Metal Gear - 20°

Pressure Angle



Trade Number: 695H



McMASTER-CARR CAD

<http://www.mcmaster.com>

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Information in this drawing is provided for reference only.

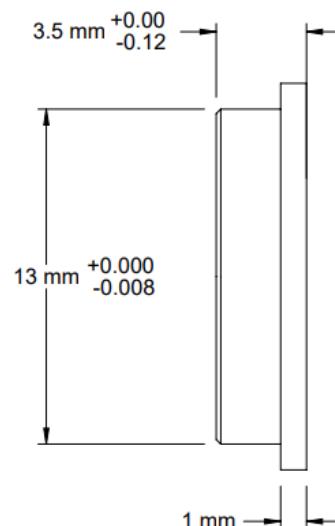
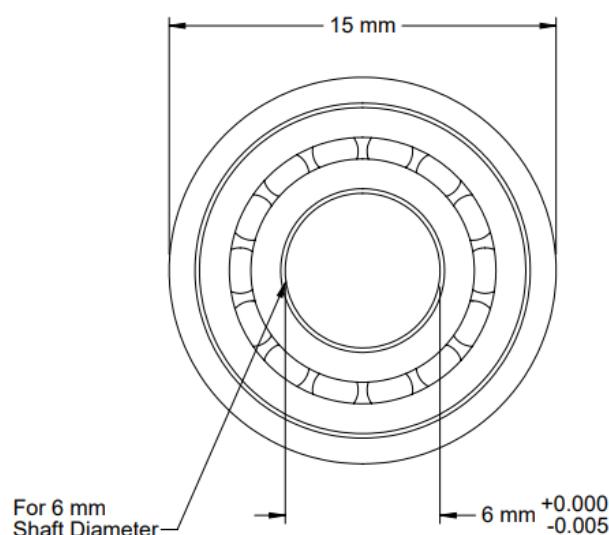
PART
NUMBER

57155K465

Flanged
Ball Bearing



Trade Number: 686H



McMASTER-CARR CAD

<http://www.mcmaster.com>

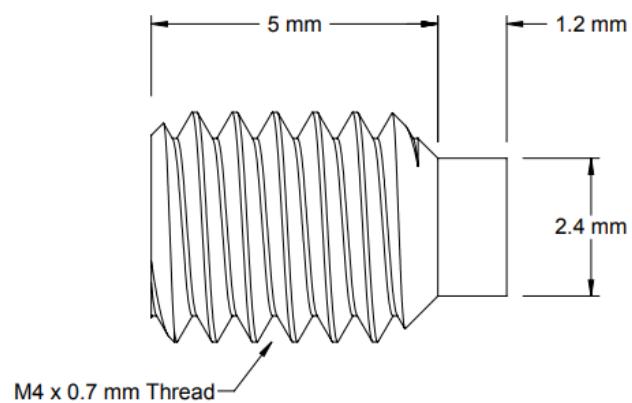
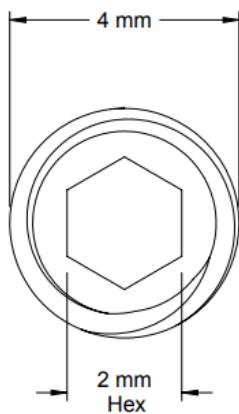
© 2020 McMaster Carr Supply Company

Information in this drawing is provided for reference only.

PART
NUMBER

57155K477

Flanged
Ball Bearing



McMASTER-CARR CAD

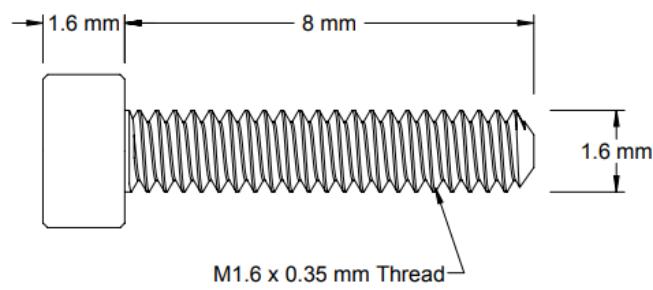
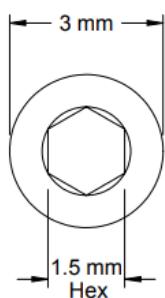
<http://www.mcmaster.com>
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PART
NUMBER

93285A211

Metric Conformable
Soft-Tip Set Screw

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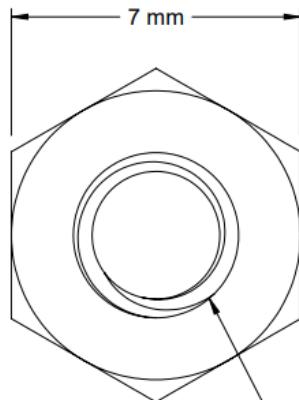
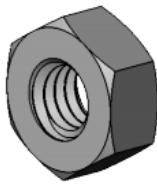
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PART
NUMBER

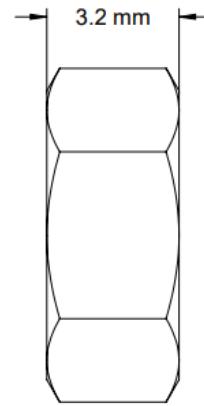
91290A041

Metric Alloy Steel

Socket Head Cap Screw



M4 x 0.7 mm Thread



McMASTER-CARR CAD

<http://www.mcmaster.com>

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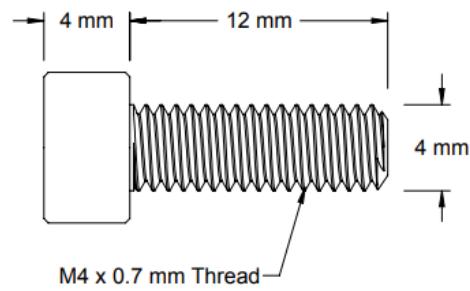
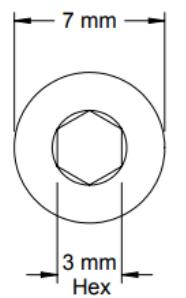
Information in this drawing is provided for reference only.

PART
NUMBER

90593A003

Metric Medium-Strength Steel

Hex Nut - Class 8



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Information in this drawing is provided for reference only.

PART
NUMBER

91290A148

Metric Alloy Steel

Socket Head Cap Screw

4.2 Process Plan

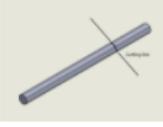
Production Plan					
Part #:	Part name: Shaft 1	Material: 303 Stainless Steel			Quantity: 1
Opr. No:	Description	Mach. Tool	Tool	Cutting Conditions	Picture
1	Cutoff 5x200mm bar to 90mm	Cutoff Wheel	R/G Abrasive Belt, 50-80 Grit	s=1067 m/min f=3500 fpm	
2	Face to 80mm length	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
3	Deburr	N/A	N/A	N/A	
4	Inspect	N/A	Functional Gage	N/A	

Figure 4.1: Process Plan for Shaft 1

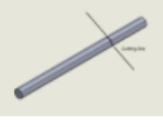
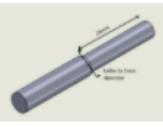
Production Plan					
Part #:	Part name: Shaft 2	Material: 303 Stainless Steel			Quantity: 1
Opr. No:	Description	Mach. Tool	Tool	Cutting Conditions	Picture
1	Cutoff 6x200mm bar to 50mm	Cutoff Wheel	R/G Abrasive Belt, 50-80 Grit	s=1067 m/min f=3500 fpm	
2	Face to 48mm length	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
3	Lathe half the shaft (24mm) to 5mm diameter	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
4	Deburr	N/A	N/A	N/A	
5	Inspect	N/A	Functional Gage	N/A	

Figure 4.2: Process Plan for Shaft 2

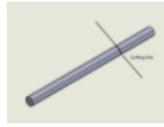
Production Plan					
Part #:	Part name: Shaft 3	Material: 303 Stainless Steel			Quantity: 1
Opr. No:	Description	Mach. Tool	Tool	Cutting Conditions	Picture
1	Cutoff 6x200mm bar to 90mm	Cutoff Wheel	R/G Abrasive Belt, 50-80 Grit	s=1067 m/min f=3500 fpm	
2	Face to 80mm length	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
3	Deburr	N/A	N/A	N/A	
4	Inspect	N/A	Functional Gage	N/A	

Figure 4.3: Process Plan for Shaft 3

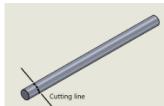
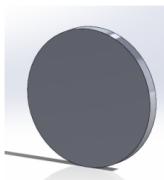
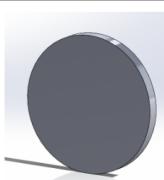
Production Plan					
Part #:	Part name: Plate	Material: 303 Stainless Steel			Quantity: 1
Opr. No:	Description	Mach. Tool	Tool	Cutting Conditions	Picture
1	Cutoff 0.025x1m bar to 0.005m in thickness	Cutoff Wheel	R/G Abrasive Belt, 50-80 Grit	s=1067 m/min f=3500 fpm	
2	Face to 0.002m in thickness	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
3	Turn the outside diameter to 23mm	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
4	Face a 14mm diameter-1mm depth hole in the center of the piece	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
5	Drill the 6 hole pattern	Drill	HSS(Twist drill) 1.8mm diameter drill bit, optimal condition	s=20ft/min f=0.0015in/re v	
6	Deburr	N/A	N/A	N/A	
7	Inspect	N/A	Functional Gage	N/A	

Figure 4.4: Process Plan for Retention Plate

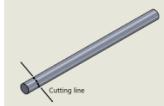
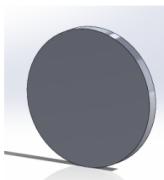
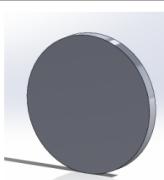
Production Plan					
Part #:	Part name: Plate with shaft hole	Material: 303 Stainless Steel			Quantity: 1
Opr. No:	Description	Mach. Tool	Tool	Cutting Conditions	Picture
1	Cutoff 0.025x1m bar to 5mm in thickness	Cutoff Wheel	R/G Abrasive Belt, 50-80 Grit	s=1067 m/min f=3500 fpm	
2	Face to 2mm in thickness	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
3	Turn the outside diameter to 23mm	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
4	Face a 14mm diameter-1mm depth hole in the center of the piece	CNC Lathe	M2/T1 Tool steels, uncoated carbide, hard	s= 640 fpm f=0.007 in/rev	
5	Drill a 6mm diameter hole through the center of the piece	Drill	HSS(Twist drill) 6mm diameter drill bit, optimal condition	s=20ft/min f=0.0015in/re v	
6	Drill the 6 hole pattern	Drill	HSS(Twist drill) 1.8mm diameter drill bit, optimal condition	s=20ft/min f=0.0015in/re v	
7	Deburr	N/A	N/A	N/A	
8	Inspect	N/A	Functional Gage	N/A	

Figure 4.5: Process Plan for Retention Plate w/ Shaft Hole

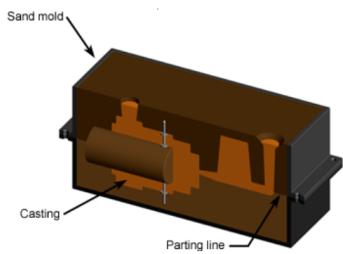
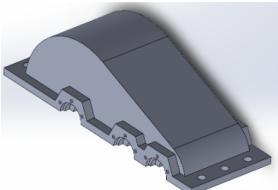
Production Plan					
Part #:	Part name: Top Body	Material: CF-8 Steel			Quantity: 1
Process	Process Name/Description: Sand Casting	Mach. Tool	Tool	Conditions	Picture
1	Material Melting	Sand Casting Setup	Furnace	1370C-1570 C	
	Molten Metal Pouring		Ladle	???	 A diagram showing a black ladle containing orange molten metal being poured into a brown sand mold. Labels indicate the 'Ladle' and 'Molten Metal'.
	Casting Cooling Time		Holding Time	210 minutes	 A diagram showing a brown sand mold containing an orange casting. Labels indicate the 'Sand mold', 'Casting', and 'Parting line'.
	Sand Blast Cleaning		Sand Blaster	N/A	 A diagram showing a dark grey, cleaned casting part with a ribbed base.
2	Deburr	N/A	N/A	N/A	
3	Inspection	N/A	Functional Gauge	N/A	

Figure 4.6: Process Plan for Shell Top

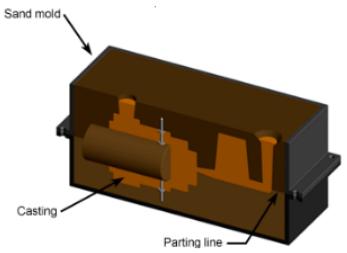
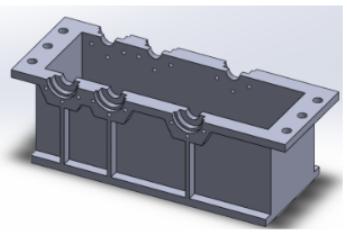
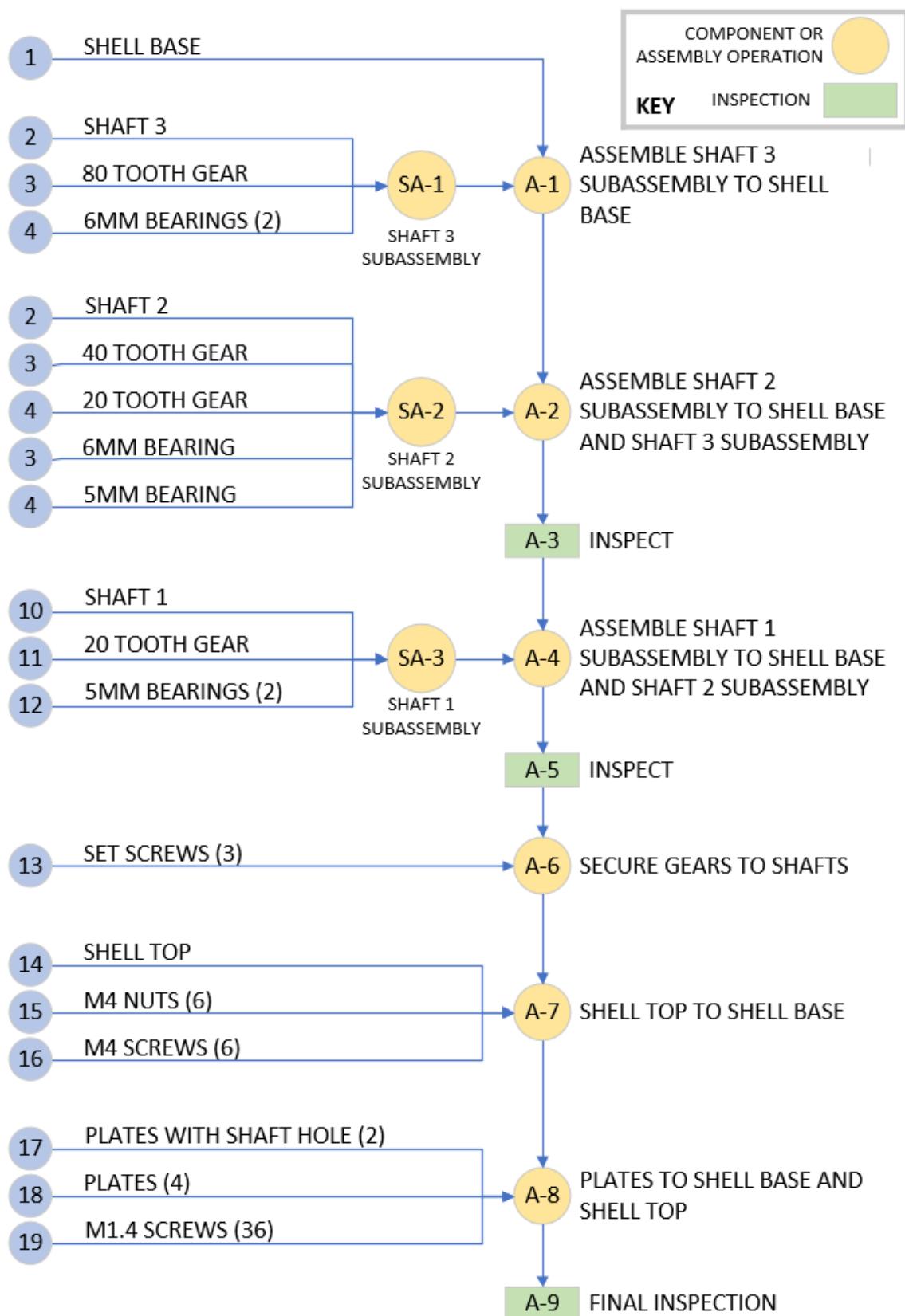
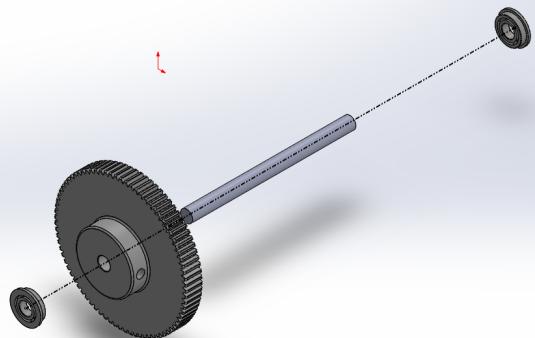
Production Plan					
Part #:	Part name: Base Body	Material: CF-8 Steel			Quantity: 1
Process	Process Name/Description: Sand Casting	Mach. Tool	Tool	Conditions	Picture
1	Material Melting	Sand Casting Setup	Furnace	1370C-1570 C	
	Molten Metal Pouring		Ladle	N/A	 <p>A diagram showing a ladle containing molten metal being poured into a sand mold. The ladle is labeled 'Ladle' and the molten metal is labeled 'Molten Metal'. The sand mold is labeled 'Sand mold'.</p>
	Casting Cooling Time		Holding Time	240 minutes	 <p>A diagram showing a casting in a sand mold. The casting is labeled 'Casting' and the parting line is labeled 'Parting line'.</p>
	Sand Blast Cleaning		Sand Blaster	N/A	 <p>A diagram showing a sand blast cleaning unit.</p>
2	Deburr	N/A	N/A	N/A	
3	Inspection	N/A	Functional Gauge	N/A	

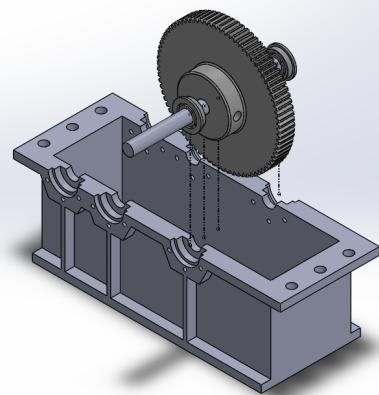
Figure 4.7: Process Plan for Shell Base

4.2 Assembly Chart

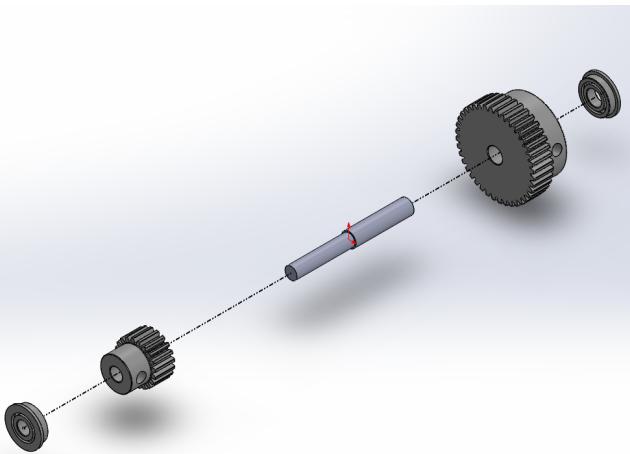




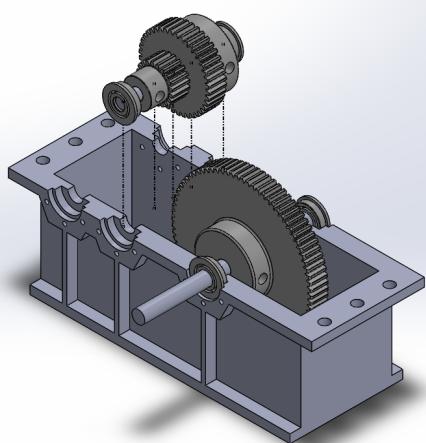
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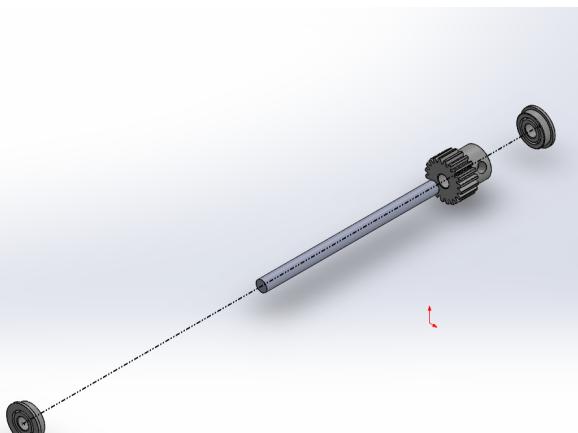
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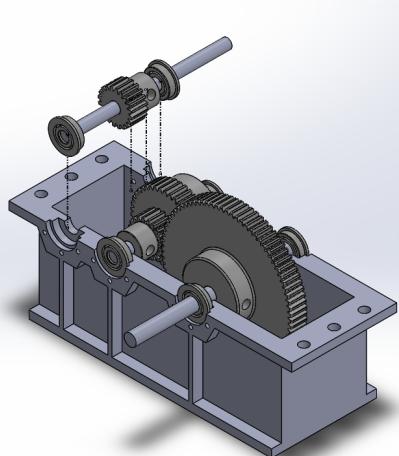
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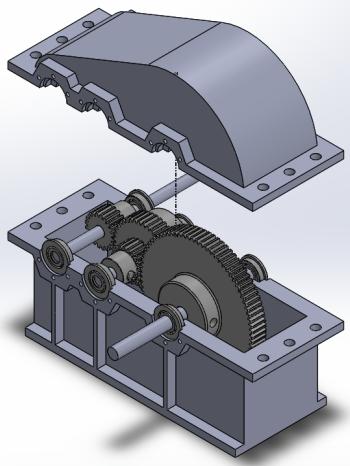
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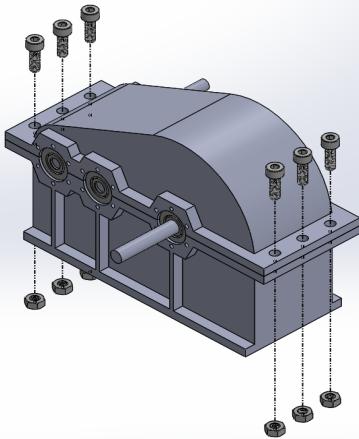
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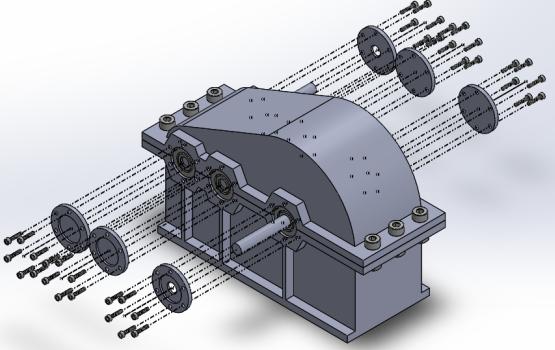
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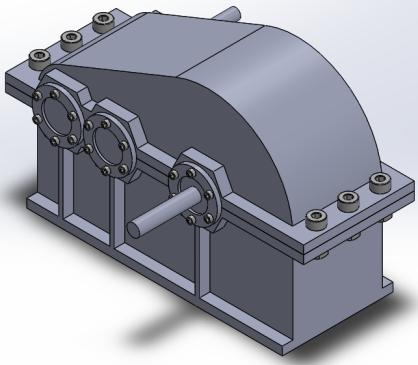
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8



9



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