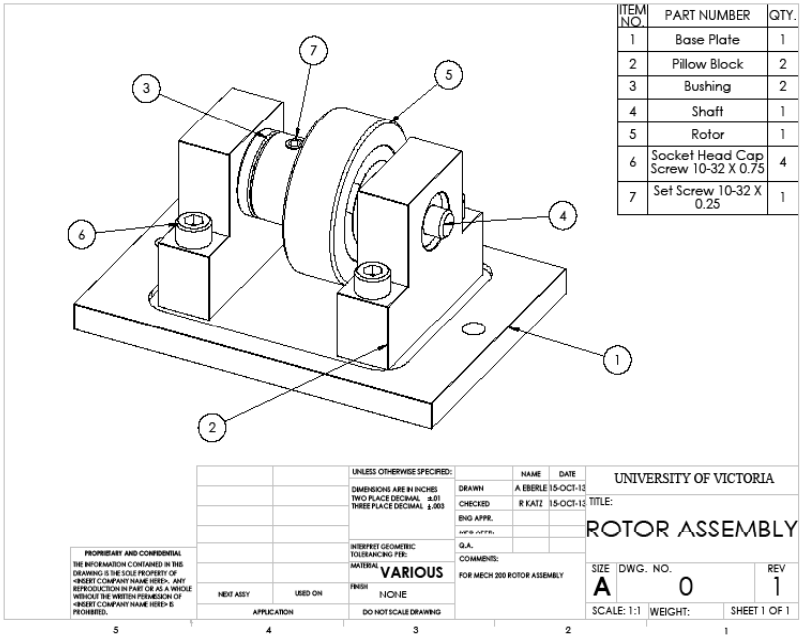
Drawings for Manufacture

Rodney Katz

Where to Start when Creating Engineering Drawings

Ask yourself…….

- How is the part going to be made?
- Have standardized sizes and parts been used where applicable?
- What are the important/critical dimensions of the part?
- How accurate does the part need to be (Tolerances)?
- What material does the part need to be made of to satisfy the design requirements (Environment, strength, cost)?
- Is the part optimized for the manufacturing methods to be employed?



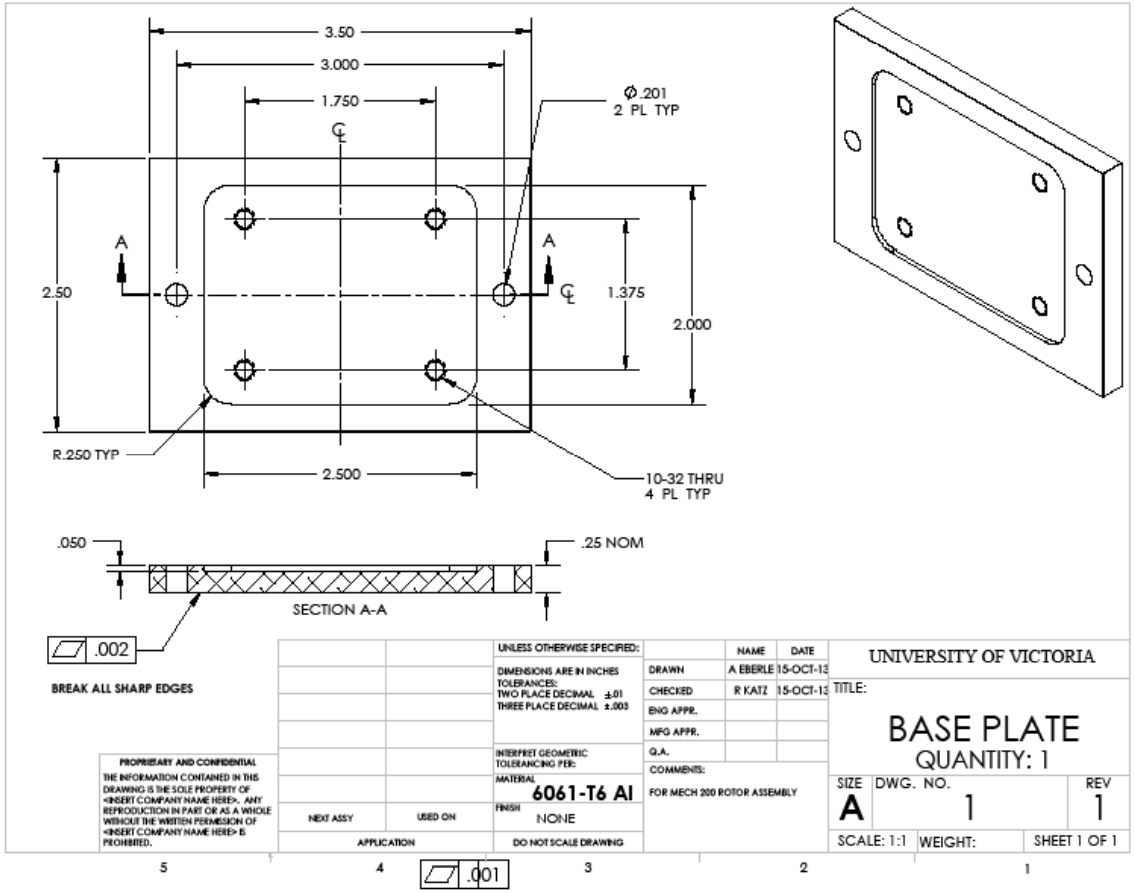
What to Think About when Creating a Set of Engineering Drawings

- Engineering Drawings are a set of instructions to be adhered to by the manufacturer
- The instructions must be as clear and concise as possible
- Consider the machines, tools, materials and skill capabilities of the manufacturing process
- Relationships of dimensions to one another
- Views necessary to adequately convey features of part (Third angle projection, section views and detailed views)
- Surface finishes (O-ring sealing surfaces, cosmetic finishes etc)
- Always consider the cost of manufacturing your part

Example 1 Specification Drawing

Important Specifications:

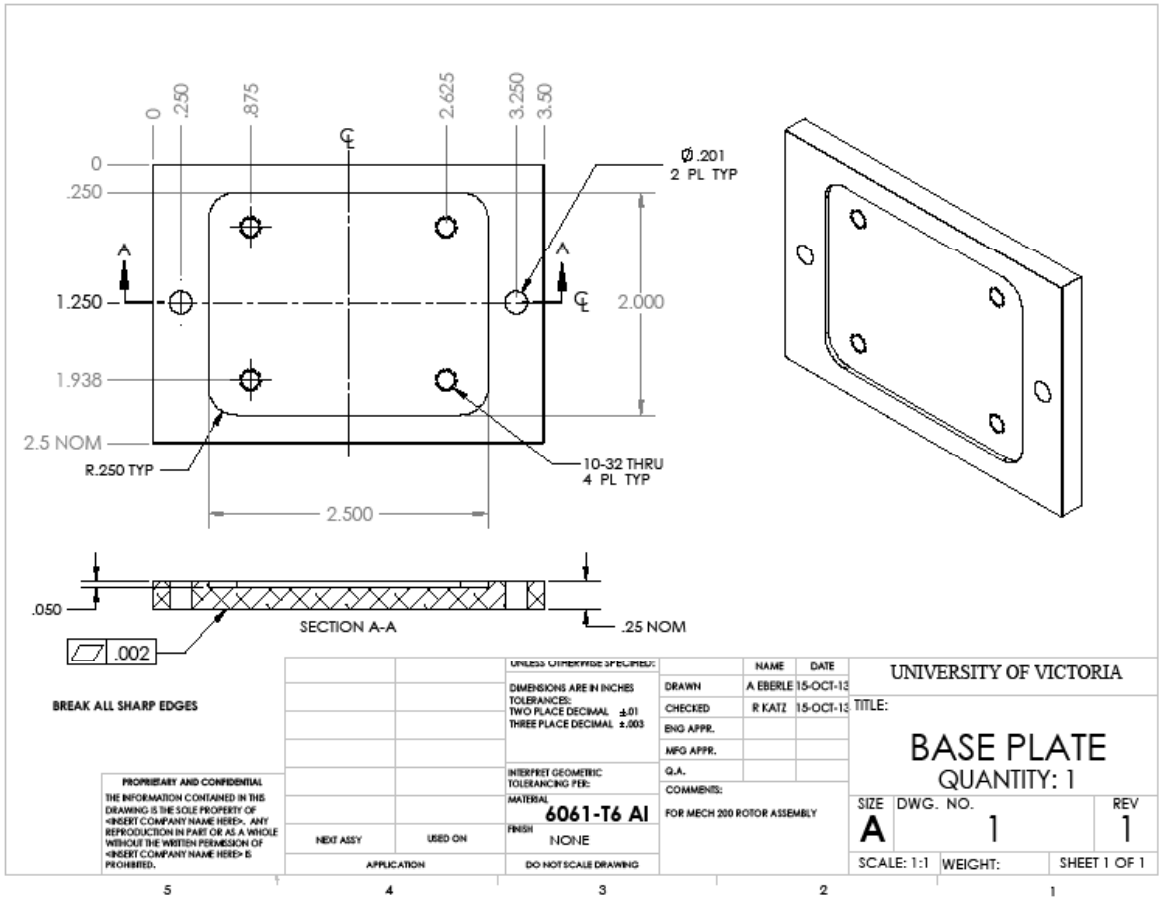
- Origin location
- Dimension tolerances
- Entity relationships
- Geometric callouts
- Material



Example 1 Shop Drawing

Important Specifications:

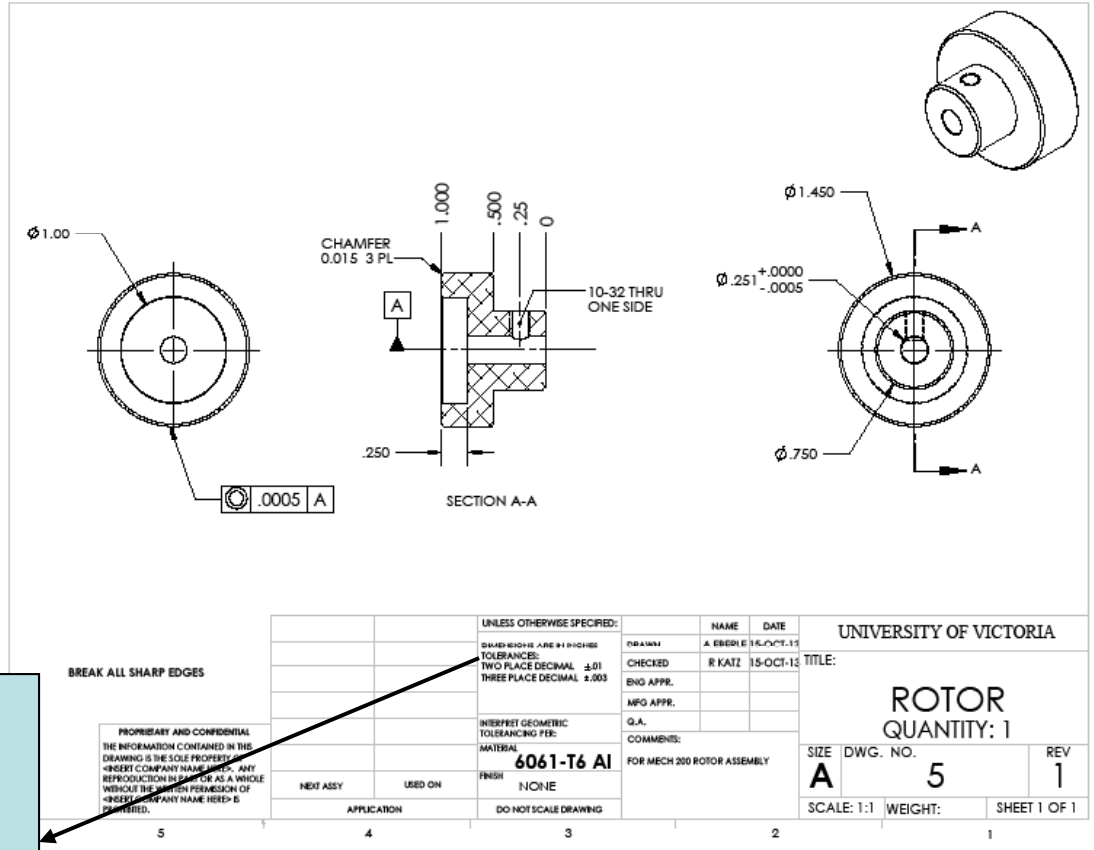
- Origin location
- Dimension tolerances
- Entity relationships
- Geometric callouts
- Material



Example 2

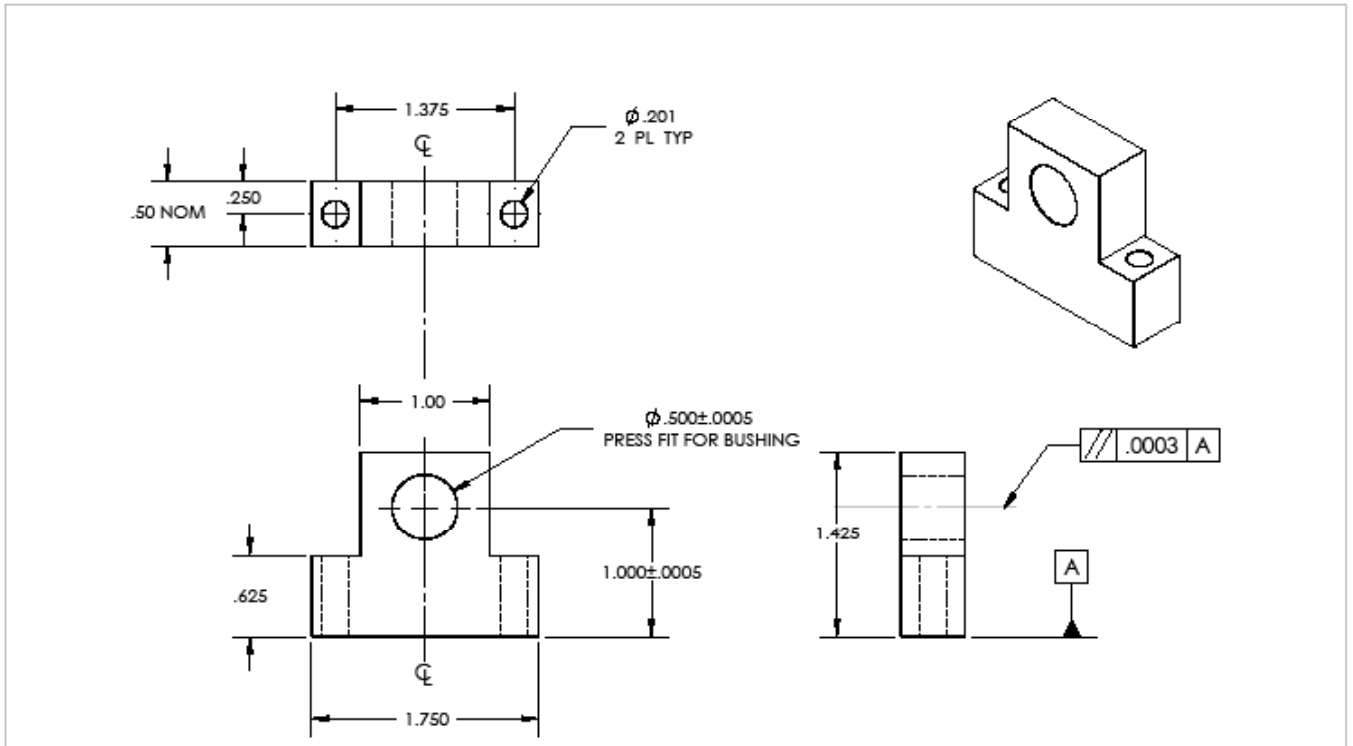
Important Specifications:

- Origin location
- Dimension tolerances
- Material designation
- Geometric callouts



DIMENSIONS ARE IN INCHES
TOLERANCES:
TWO PLACE DECIMAL +/- .01”
THREE PLACE DECIMAL +/- .003”
UNLESS OTHERWISE SPECIFIED

Example 3



BREAK ALL SHARP EDGES

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
TWO PLACE DECIMAL ±.01
THREE PLACE DECIMAL ±.003
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL 6061-T6 Al
FINISH NONE
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	A EBERLE	15-OCT-13
CHECKED	R KATZ	15-OCT-13
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
FOR MECH 200 ROTOR ASSEMBLY

UNIVERSITY OF VICTORIA

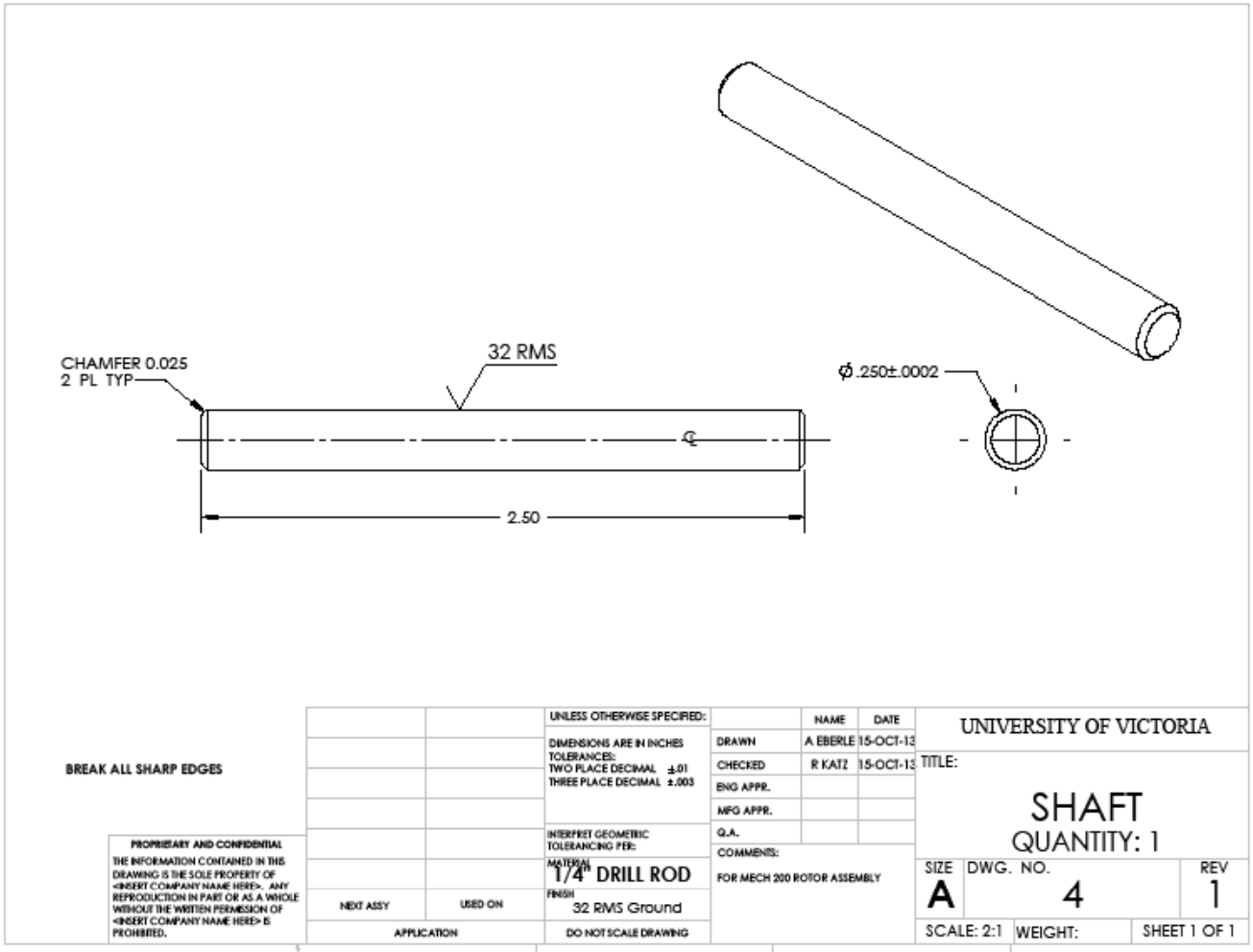
TITLE:
PILLOW BLOCK
QUANTITY: 2

SIZE	DWG. NO.	REV
A	2	1

SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

Example 4


CHAMFER 0.025
2 PL TYP
32 RMS
ϕ .250±.0002
2.50
BREAK ALL SHARP EDGES
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NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
TWO PLACE DECIMAL ±.01
THREE PLACE DECIMAL ±.003
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
1/4" DRILL ROD
FINISH
32 RMS Ground
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
A EBERLE
15-OCT-13
CHECKED
R KATZ
15-OCT-13
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
FOR MECH 200 ROTOR ASSEMBLY
UNIVERSITY OF VICTORIA
TITLE:
SHAFT
QUANTITY: 1
SIZE
A
DWG. NO.
4
REV
1
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
5
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1

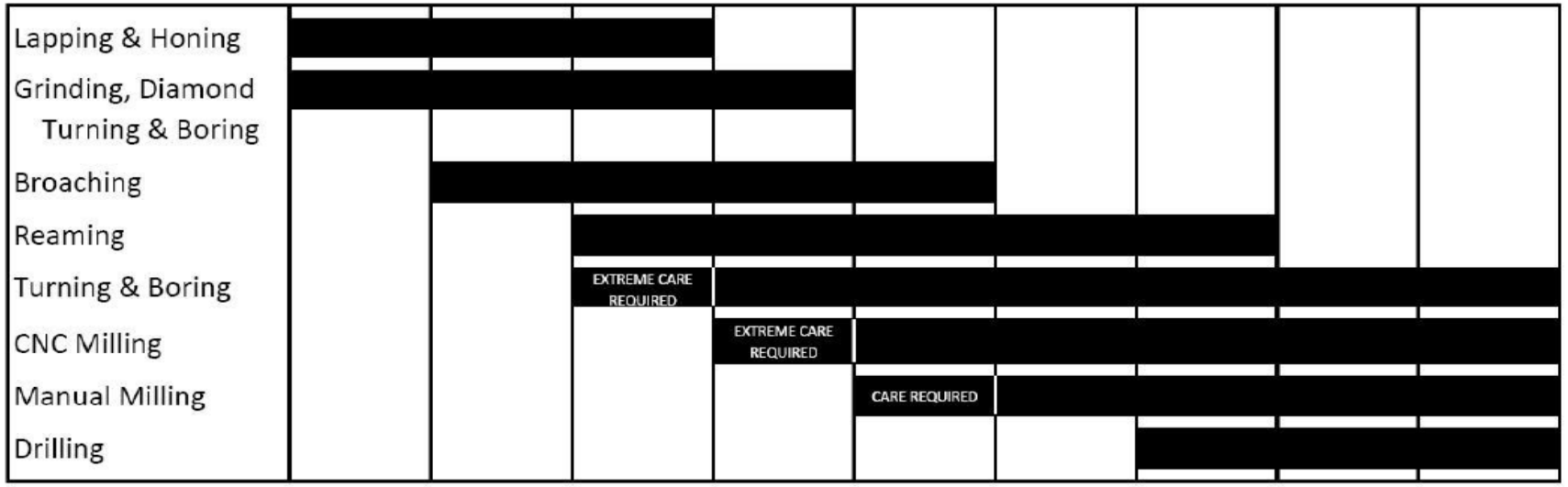
Tolerancing

Things to consider…

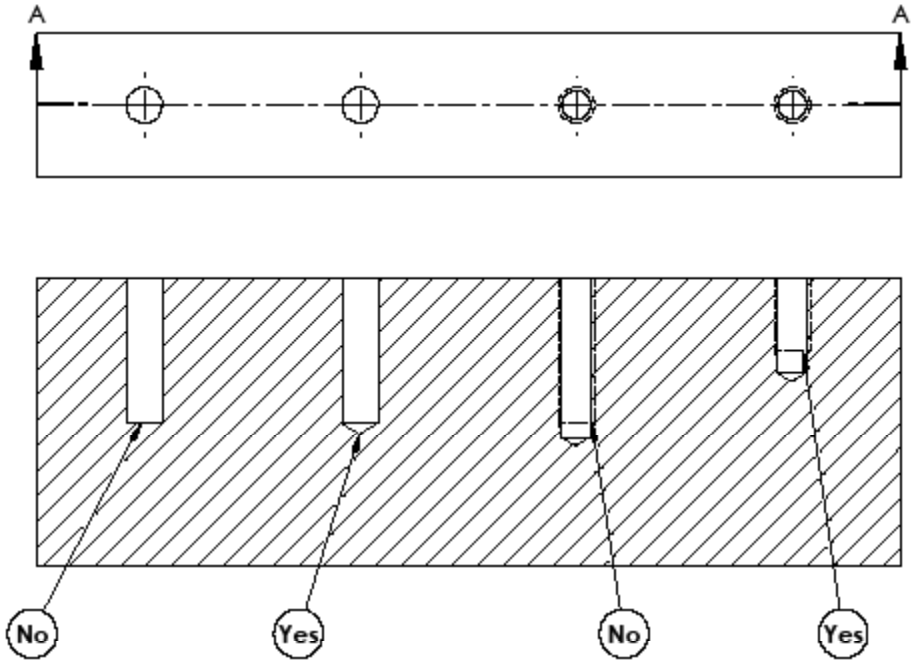
- What needs to be have tolerances and what doesn't (Nominal Sizes)
    - -Nominal Size (Nom.) is the supplied material size without machining
- Precision Required (number of decimal places).
    - -Excessive tolerancing can be extremely time consuming resulting in high manufacturing costs
- Avoid tolerance accumulation/stacking

Tolerances Related To Machining Processes and Sizes

Range of Sizes From	To and including	Tolerances								
0.010	0.599	0.00015	0.0002	0.0003	0.0005	0.0008	0.0012	0.002	0.003	0.005
0.600	0.999	0.00015	0.00025	0.0004	0.0006	0.001	0.0015	0.0025	0.004	0.006
1.000	1.499	0.0002	0.0003	0.0005	0.0008	0.0012	0.002	0.003	0.005	0.008
1.500	2.799	0.00025	0.0004	0.0006	0.001	0.0015	0.0025	0.004	0.006	0.010
2.800	4.499	0.0003	0.0005	0.0008	0.0012	0.002	0.003	0.005	0.008	0.012
4.500	7.799	0.0004	0.0006	0.001	0.0015	0.0025	0.004	0.006	0.010	0.015
7.800	13.599	0.0005	0.0008	0.0012	0.002	0.003	0.005	0.008	0.012	0.020
13.600	20.999	0.0006	0.001	0.0015	0.0025	0.004	0.006	0.010	0.015	0.025



Common Hole Mistakes to Avoid



No Flat bottom drilled holes **Tapped holes excessively deep**

Tips and Tricks

- Incorporate devices which will allow room for inconsistencies in manufacturing and materials
- When possible draw parts to a 1:1 scale and print to get a real sense of size
- Consult the manufacturer before producing detailed drawings
- Provide the manufacturer an assembly drawing in order to help them understand the integration of the part
- Consider the cutting tools required to machine the part in order to determine if the feature is viable (Milled feature width to depth ratio)

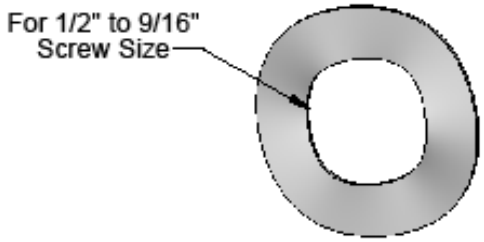
Drafting Tips

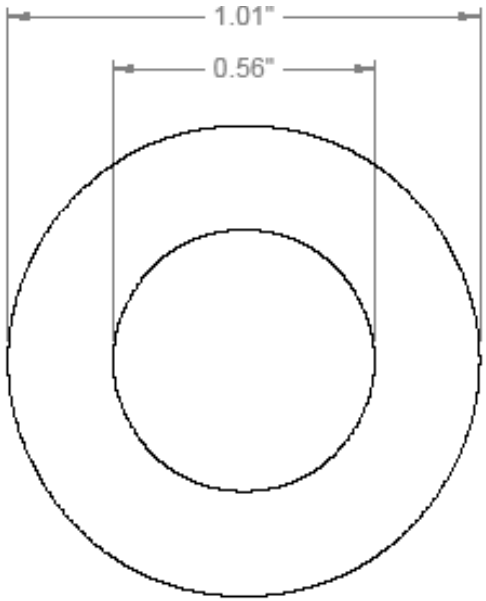
- Text should be large enough to be read easily
- Ensure appropriate scale and location for pointer lines (arrows)
- Lines should be dark and legible
- Avoid using pale colours in drawings
- Give parts unique names and part numbers
- Maintain a revision system for updated packages
- Relax tolerances as much as possible
- Avoid the use of built-in cad software for calling out tap drill sizes (consult tap drill sizes chart or the manufacturer)

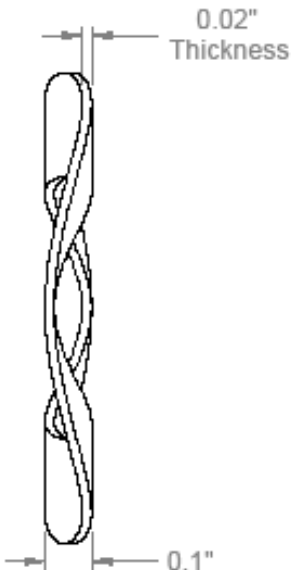
Common Tap and Clearance Drill Sizes

Tap	Tap Drill		Clearance Drill					
Nom Size - T.P.I.	Drill #	Dec Equ	Tight/Precision Clearance		Medium Clearance		Loose Clearance	
			Drill #	Dec Equ	Drill #	Dec Equ	Drill #	Dec Equ
2 - 56	49	0.073	44	0.086	43	0.089	42	0.093
4 - 40	42	0.093	35	0.110	33	0.113	32	0.116
6 - 32	35	0.110	29	0.136	28	0.140	27	0.144
8 - 32	28	0.140	20	0.161	18	0.169	17	0.173
10 - 24	23	0.154	12	0.189	10	0.193	7	0.201
10 - 32	20	0.161	12	0.189	10	0.193	7	0.201
1/4 - 20	6	0.204	1/4	0.250	6.5(mm)	0.255	17/64	0.266
1/4 - 28	7/32	0.218	1/4	0.250	6.5(mm)	0.255	17/64	0.266
5/16 - 18	17/64	0.265	5/16	0.312	8(mm)	0.315	21/64	0.328
3/8 - 16	21/64	0.320	3/8	0.375	25/64	0.390	13/32	0.406
3/8 - 24	R	0.339	3/8	0.375	25/64	0.390	13/32	0.406
7/16 -14	3/8	0.375	7/16	0.438	29/64	0.453	15/32	0.469
7/16 - 20	25/64	0.390	7/16	0.438	29/64	0.453	15/32	0.469
1/2 - 13	7/16	0.437	1/2	0.500	13(mm)	0.512	9/16	0.563
1/2 - 20	29/64	0.453	1/2	0.500	13(mm)	0.512	9/16	0.563

Note: For tap drill and clearance drill sizes outlined in the table above are sufficient for most work conducted in the Uvic Mech Eng Machining Facility. For critical for high stress applications consult shop supervisor before selecting a tap or clearance drill.





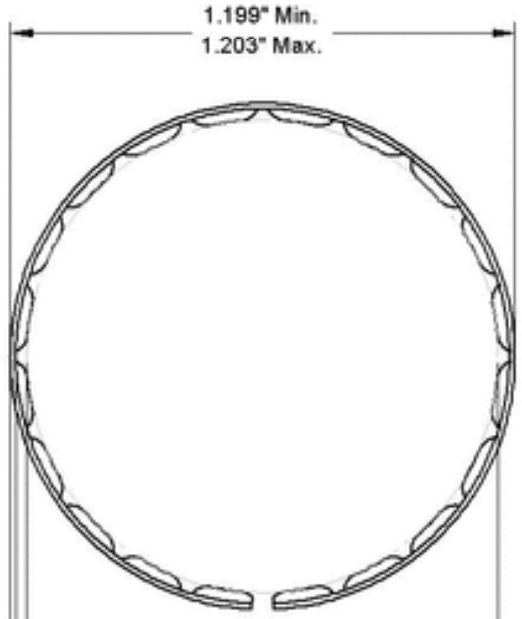


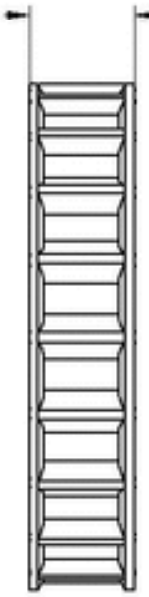
McMASTER-CARR

http://www.mcmaster.com

PART NUMBER **92161A033**

18-8 Stainless Steel
Triple-Wave Washer





Shim ring varies from
0.008" to 0.020" in thickness.

Corrugations vary from 0.0295" to 0.0492" in height.

McMASTER-CARR CAD

PART NUMBER 3547K15

Type 301 Stainless Steel
Bearing Shim Ring