MAC – 142, Machining Applications II

Orientation and Introduction

Introduction

Concept Content:

Instructor Note: In this section you will give an introduction of yourself to your class. This is an opportunity to state your relevant experiences and credentials to teach this subject along with your personal background. This can help connect with students. You can make a video introduction and upload it to this page as well.

Also, this is where you will give a brief overview of the course and what it's contents will be. There is a section later on in this module where you will give more detail about the course.

Course Syllabus

Concept Goals:

After completion of this course, students will be able to:

1. Safe and competent performance of precision measurement, filing, drilling, sawing, turning, and milling
2. Ability to anticipate, choose and troubleshoot the proper tooling based on manufacturing requirements
3. Ability to manufacture piece parts and assemblies to specification

Concept Content:

Instructor Note: This is where you will upload the syllabus. You can do this either by uploading the syllabus text here or you can upload a copy of the syllabus under the resources tab for this section. If you do upload it to the resources, please be sure to give instructions to your students to look for the

syllabus there.

Course Resources

Concept Goals:

You can leave this section blank provided you uploaded the student learning outcomes to the previous section.

Concept Content:

Instructor Note: This is where you would outline student support resources such as tutoring services, listing your office hours, contact info for support for your college's learning management system, etc. If there are documents you wish to upload, be sure to upload them to the resources tab and give instructions for the students to find the documents there.

Course Overview

Concept Goals:

After completion of this course, students will be able to:

1. Safe and competent performance of precision measurement, filing, drilling, sawing, turning, and milling
2. Ability to anticipate, choose and troubleshoot the proper tooling based on manufacturing requirements
3. Ability to manufacture piece parts and assemblies to specification

Concept Content:

This course provides instruction in the wide variety of processes associated with machining. Topics include safety, equipment set-up, holding fixtures, tooling, cutting speeds and depths, metal properties, and proper finishes. Upon completion, students should be able to safely demonstrate advanced machining operations, accurately measure components, and produce accurate components with a proper finish.

Module	Module Learning Objectives

Unit 1: Weeks 1-3 - Introduction to MAC 142	• Know basic manufacturing processes and the differences between them (SLO 3) • Become familiar with basic blueprint types (SLO 3) • Know the differences between 2D and 3D models (SLO 3) • Have basic knowledge of how to do conventional and climb milling (SLO 2, SLO 3) • Understand the differences between conventional and climb milling (SLO 2, SLO 3) • Describe the process of tramming the head on a milling machine (SLO 1, SLO 3) • List reasons why threading is important to machining (SLO 2, SLO 3) • Explain why tolerances are important to machining (SLO 1, SLO 2) • Perform surface grinding (SLO 2) • Perform cuts using a bandsaw (SLO 1)
Unit 2: Weeks 4-14 Projects	• Demonstrate the ability to read and understand blueprints in order to create machining projects (SLO 1, SLO 2, SLO 3) • Demonstrate the basic manufacturing skills needed to complete various machining projects (SLO 1, SLO 2, SLO 3)
Unit 3: Week 15 Final Exam	• Demonstrate understanding and application of knowledge of the course

Notes/Helpful Tips

Next Steps…

Your Census assignments are REQUIRED in order to remain in the class and they MUST be completed prior to the Census Date **[insert census date here]**. **If you do not have a census date requirement, you can delete this section.**

Effective note taking is also important for not only this course, but for your career as well. Note taking is a great way to retain information. The process of taking notes can keep you alert and focused on the information being presented. It also keeps your mind engaged with what you are hearing, increasing the likelihood you will retain that information. Note taking can also allow you to better organize your thoughts on the information being discussed.

Here is a video that provides some tips for effective note taking.

Also, here is a list of what tools you will need for the class.

Unit 1 Introduction to the Course (Weeks 1-3)

Week 1: Review of Manufacturing Processes

Concept Goals:

By the end of this module, you should be able to:

- Know basic manufacturing processes and the differences between them (SLO 3)
- Become familiar with basic blueprint types (SLO 3)
- Know the differences between 2D and 3D models (SLO 3)
- Have basic knowledge of how to do conventional and climb milling (SLO 2, SLO 3)
- Understand the differences between conventional and climb milling (SLO 2, SLO 3)
- Describe the process of tramming the head on a milling machine (SLO 1, SLO 3)

Concept Content:

Welcome to MAC 142! This week will be used to introduce you to the course and give some new material to study before we start our projects for this semester. We will cover this over the next few weeks.

This week at a glance:

Reading:

Embedded below

Videos:

Embedded below

Assignments:

Module 1 Quiz - 9 Questions - Located under the assignments tab

Hello Class! This week is our introduction to what you will be doing this semester. As the lecture presentation shows, this course will be focused on projects, much like MAC 141 was. However, this time, we will be grading you on accuracy and overall quality of work rather than just completing the work. Please review the presentation to get a good idea of how this course will go.

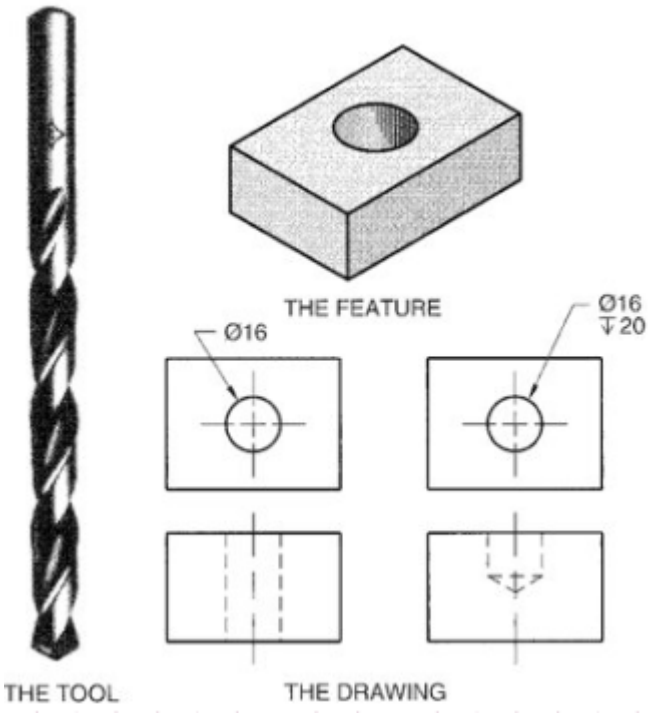
There is also material for us to go over as well including manufacturing processes and a review on

blueprint reading. This week is to get your gears turning again and next week we will dive right on in to our first project of the semester!

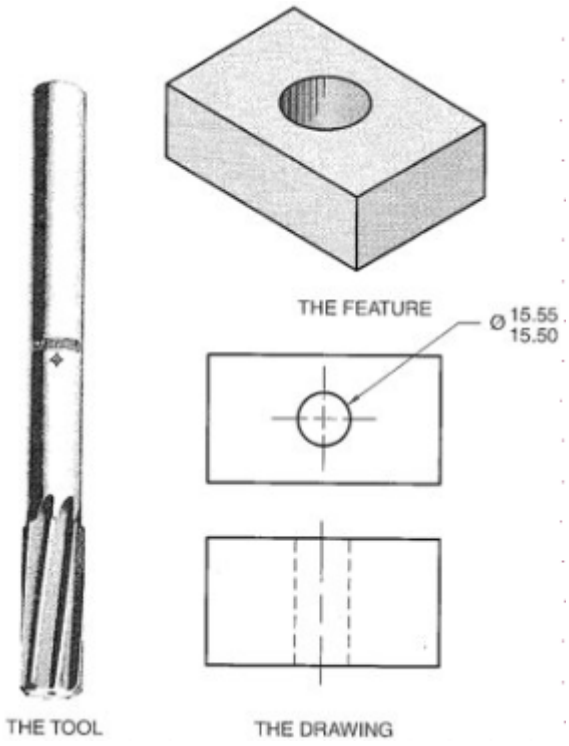
Reading:

What’s a Manufacturing Process?

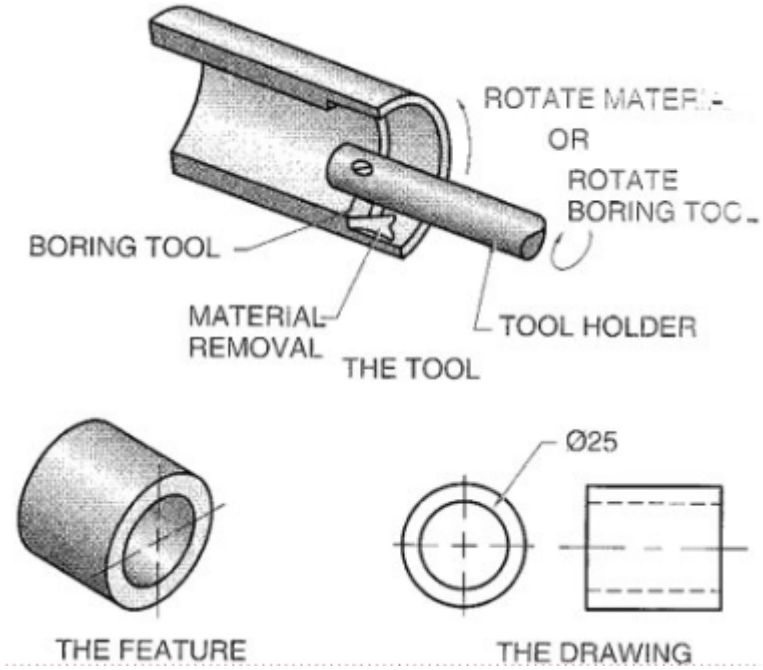
- **Drill**



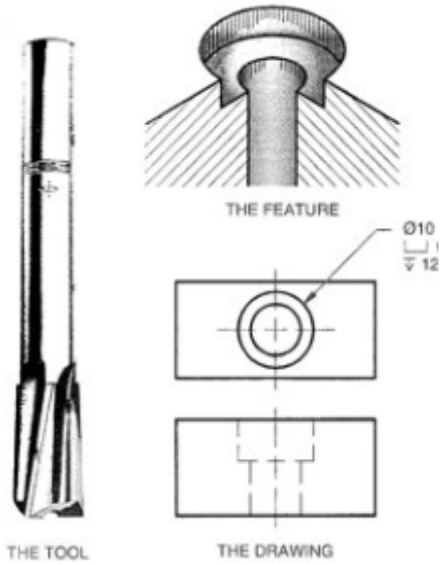
- **Ream**

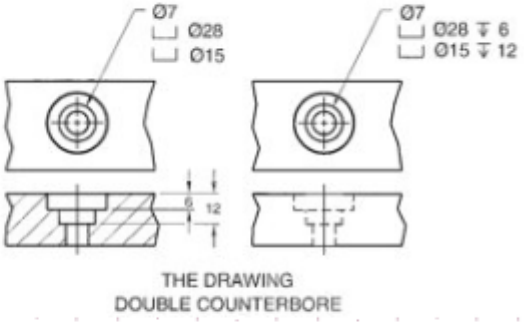


- **Bore**

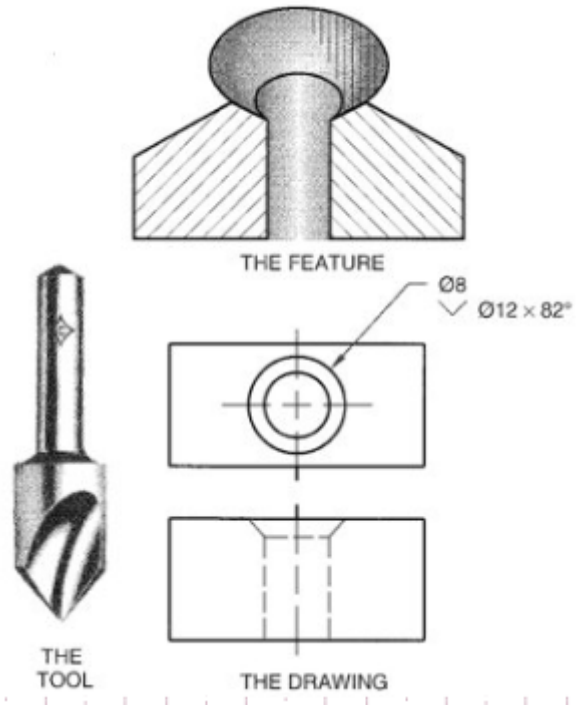


- **Counterbore**

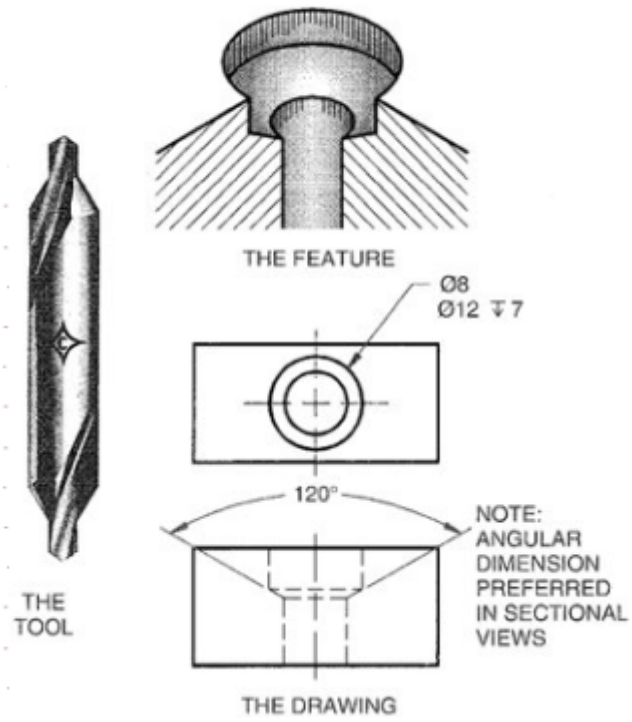




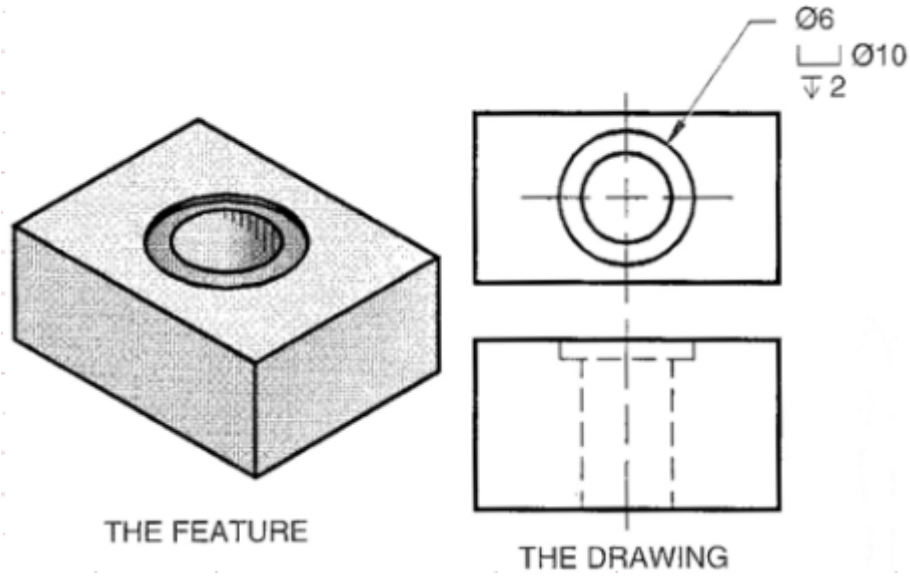
- **Countersink**



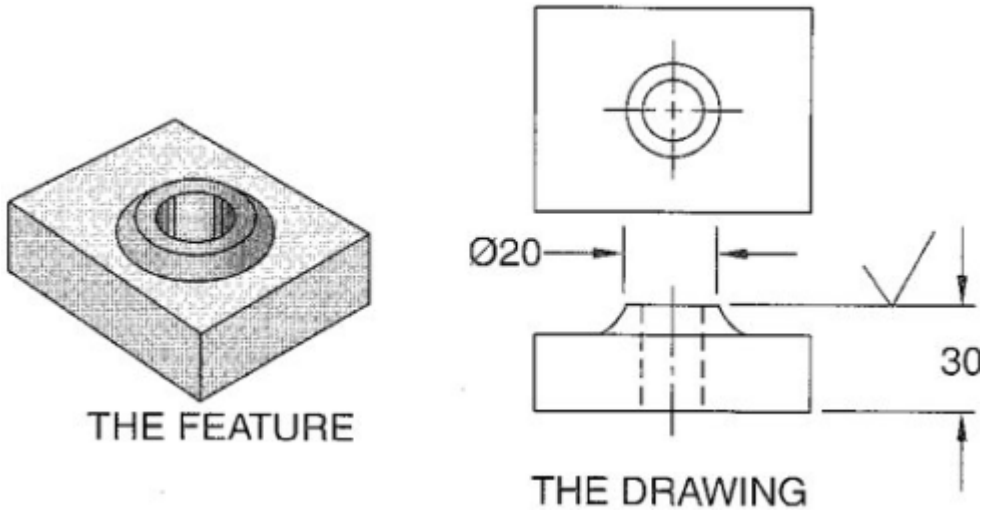
- **Counterdrill**


THE FEATURE
Ø8
Ø12 ↧7
120°
NOTE:
ANGULAR
DIMENSION
PREFERRED
IN SECTIONAL
VIEWS
THE
TOOL
THE DRAWING

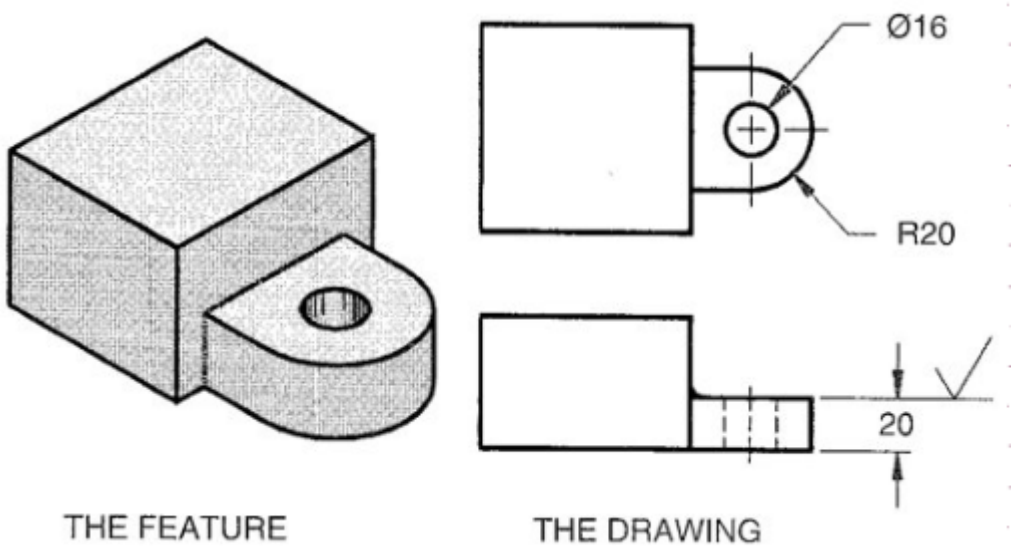
- **Spotface**


Ø6
Ø10
2
THE FEATURE
THE DRAWING

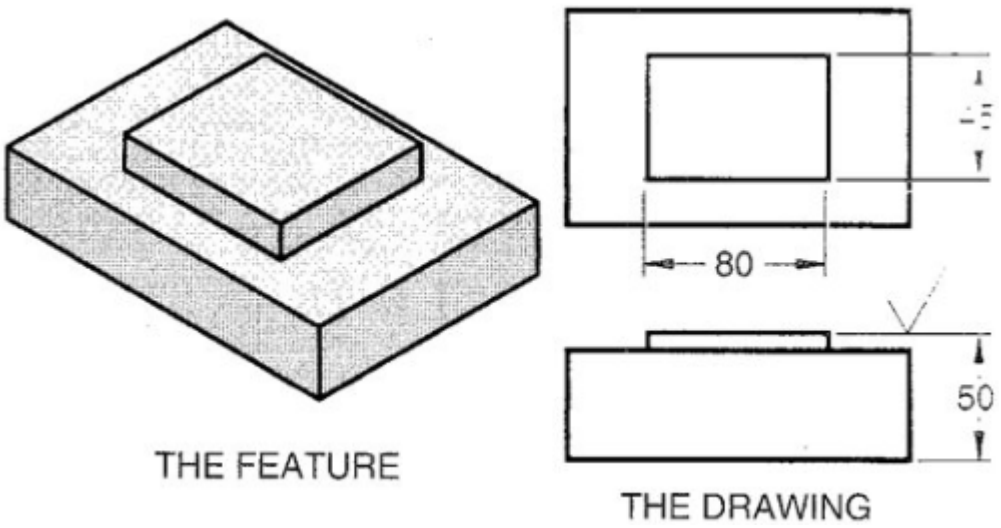
- **Boss**


Ø20
30
THE FEATURE
THE DRAWING

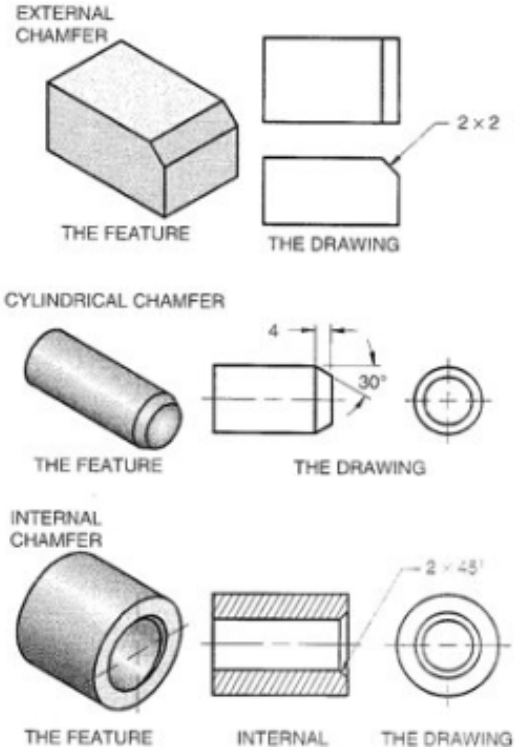
- **Lug**


Ø16
R20
20
THE FEATURE
THE DRAWING

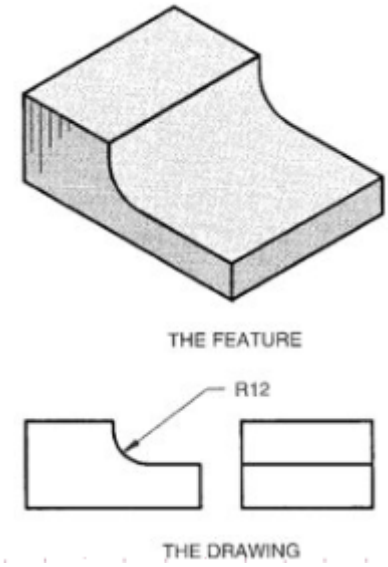
- **Pad**


80
50
THE FEATURE
THE DRAWING

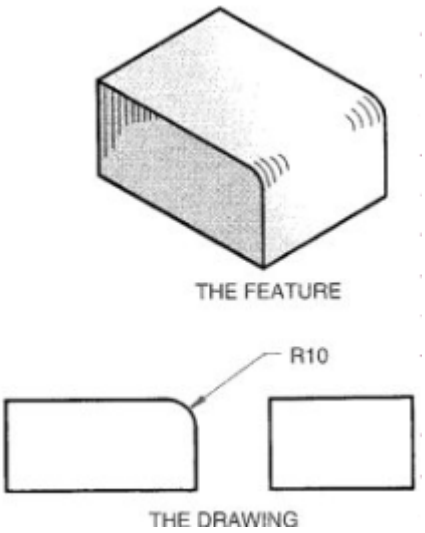
- **Chamfer**


EXTERNAL
CHAMFER
2 × 2
THE FEATURE
THE DRAWING
CYLINDRICAL CHAMFER
4
30°
THE FEATURE
THE DRAWING
INTERNAL
CHAMFER
2 × 45°
THE FEATURE
INTERNAL
THE DRAWING

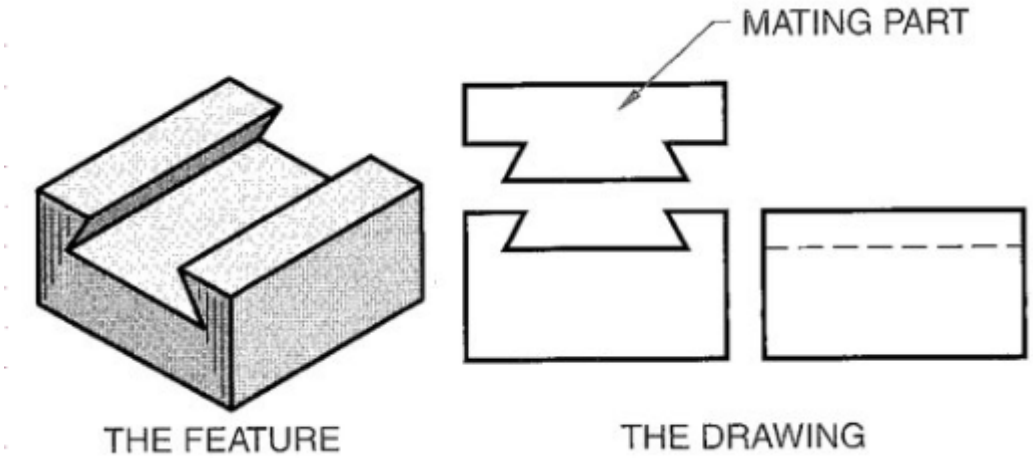
- **Fillet**



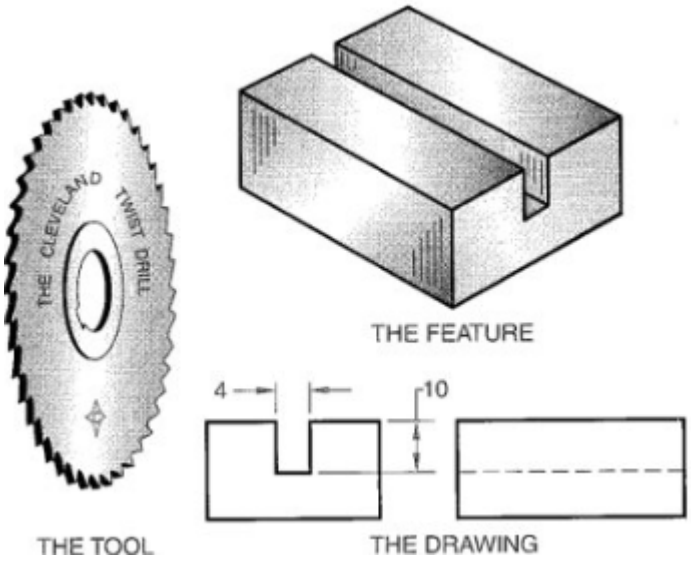
- **Round**



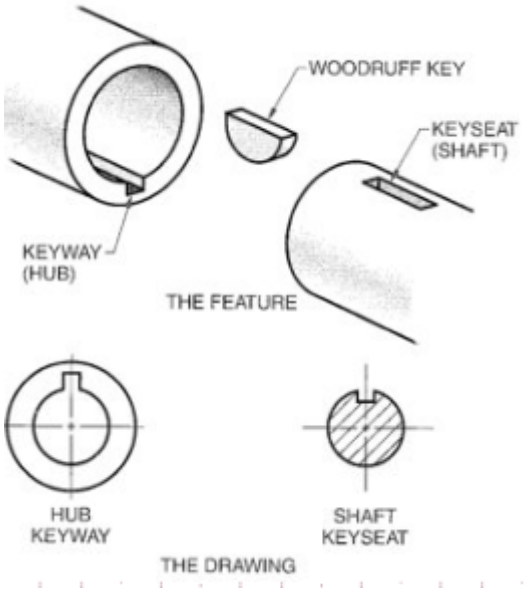
- **Dovetail**



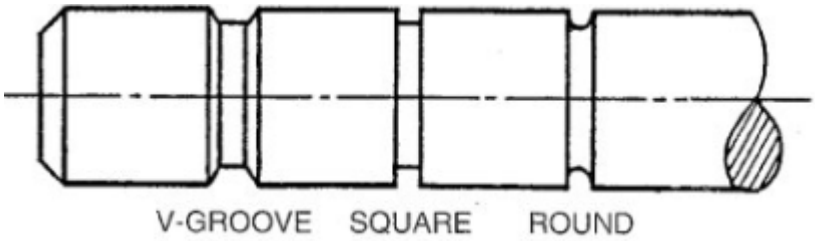
- **Kerf**



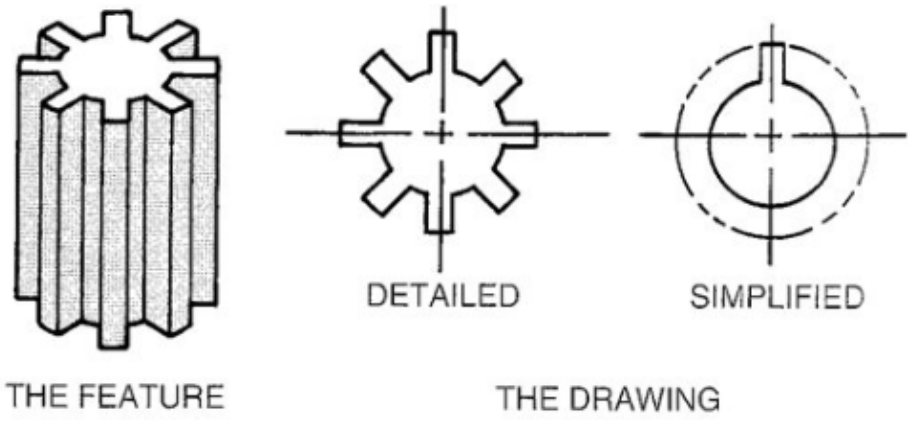
- **Key and Keyset or Keyway**


WOODRUFF KEY
KEYSEAT
(SHAFT)
KEYWAY
(HUB)
THE FEATURE
HUB
KEYWAY
SHAFT
KEYSEAT
THE DRAWING

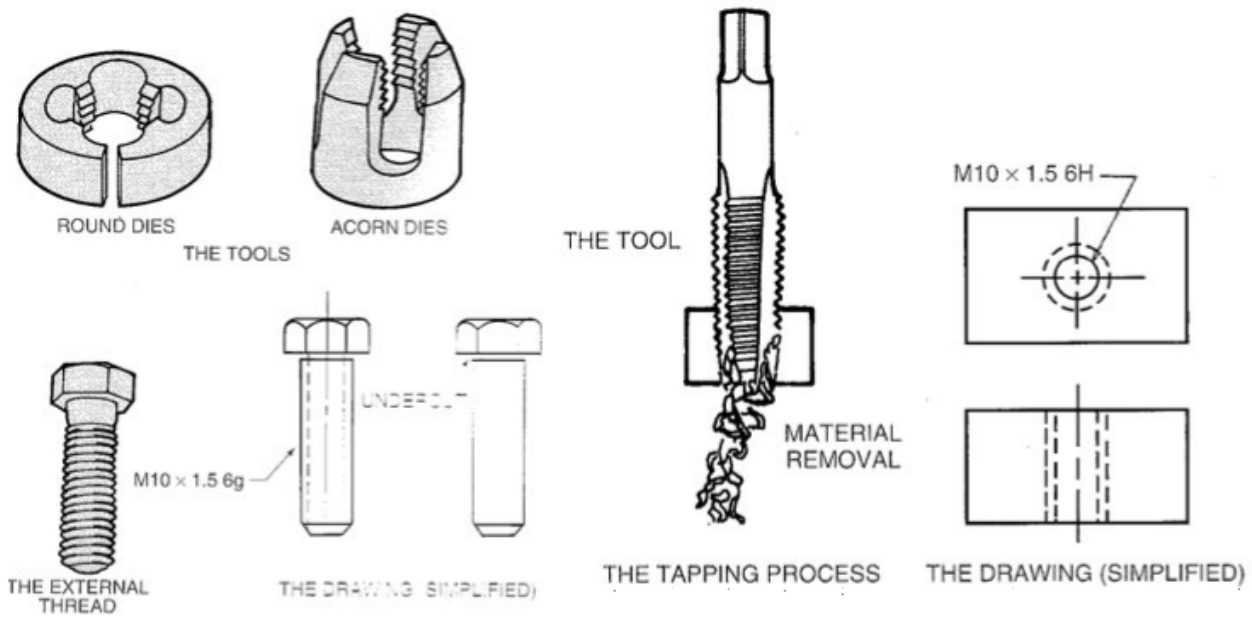
- **Neck**


V-GROOVE
SQUARE
ROUND

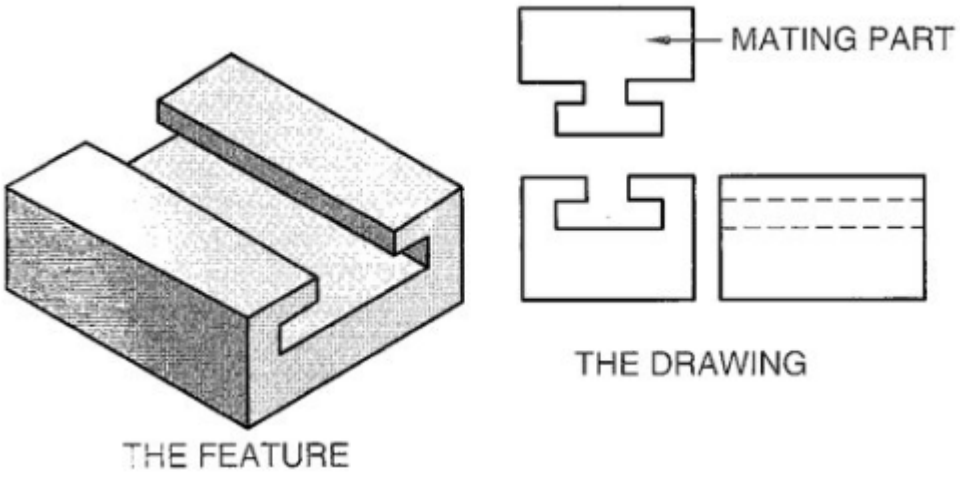
- **Spline**



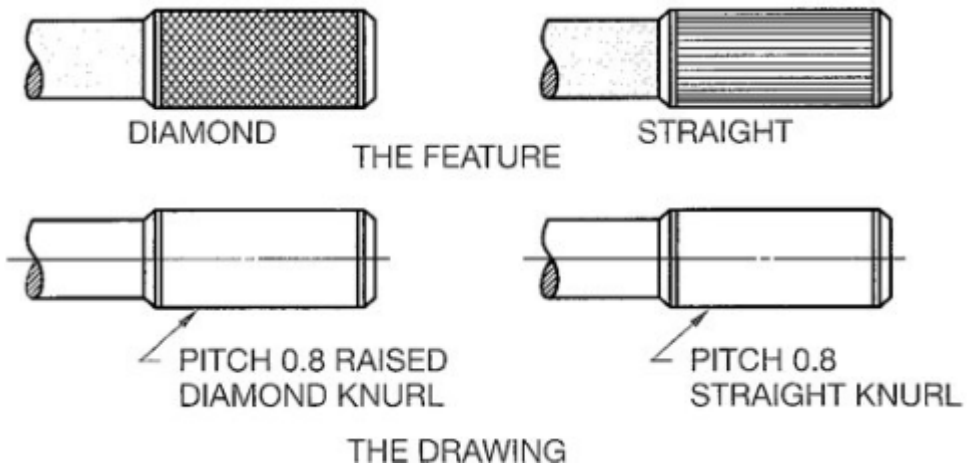
- **Threads**


ROUND DIES
ACORN DIES
THE TOOLS
THE TOOL
M10 × 1.5 6H
M10 × 1.5 6g
MATERIAL
REMOVAL
THE EXTERNAL
THREAD
THE TAPPING PROCESS
THE DRAWING (SIMPLIFIED)

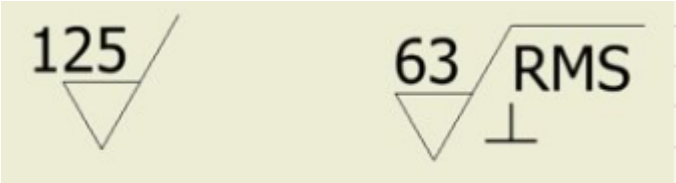
- **T-Slot**


MATING PART
THE FEATURE
THE DRAWING

- **Knurl**



- **Surface Texture or Finish**
  - Parts may be finished to a particular smoothness or roughness
  - For the U.S. the lower the finish number the smoother the finish

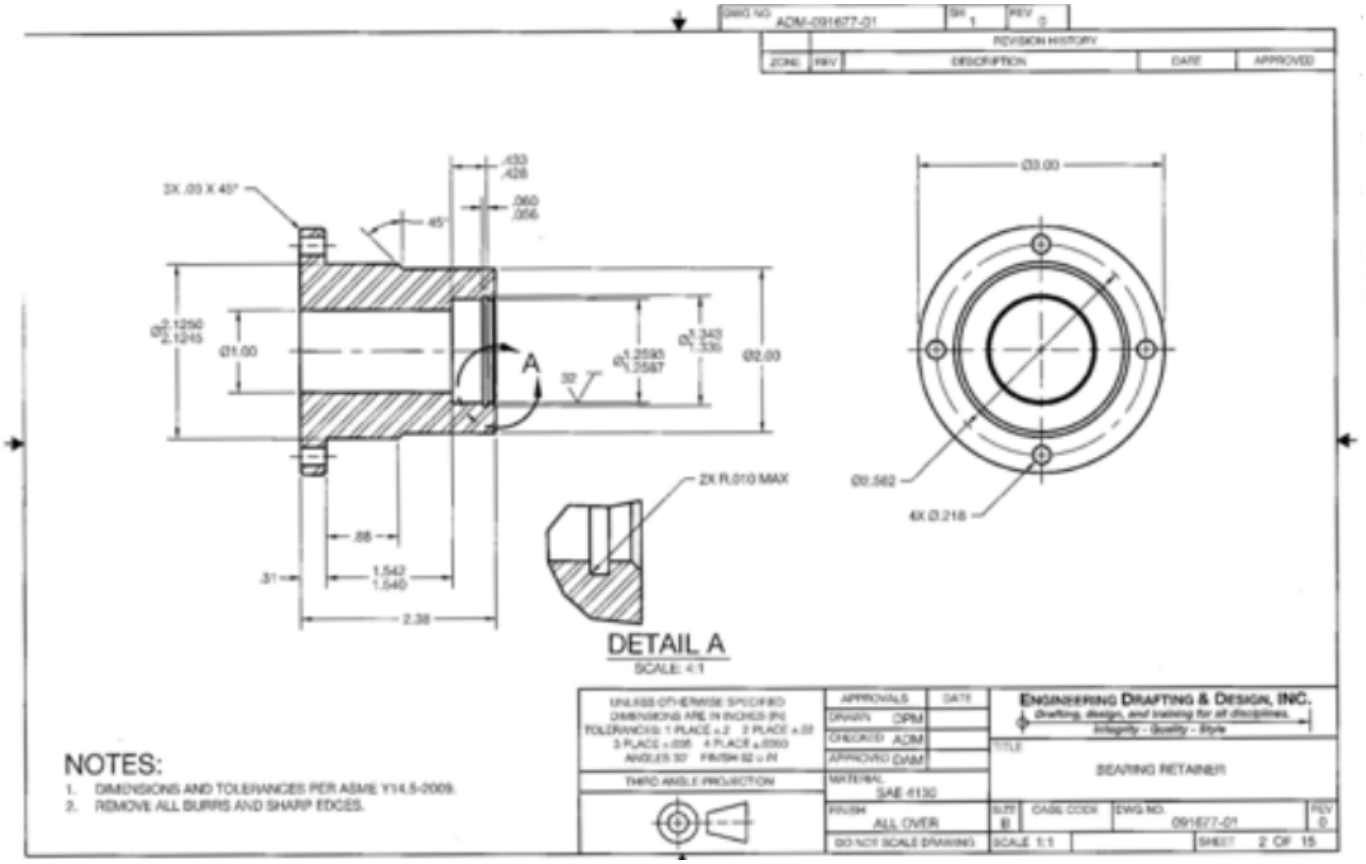


References

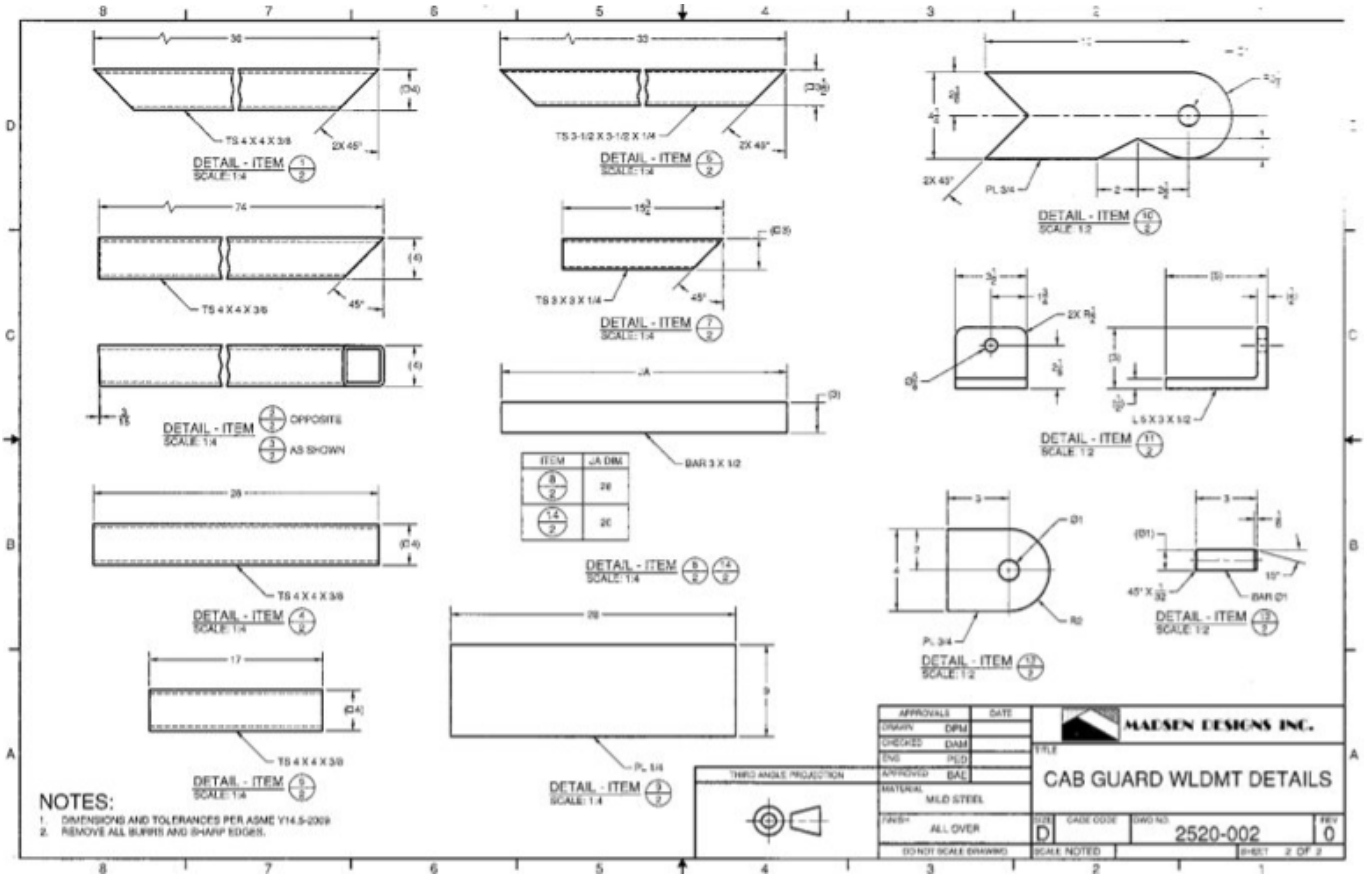
Credits:

Unless indicated otherwise all images are from Madsen, David A., and David P. Madsen. Print Reading for Engineering and Manufacturing Technology. Clifton Park, NY:
Delmar, Cengage Learning, 2013. Print.

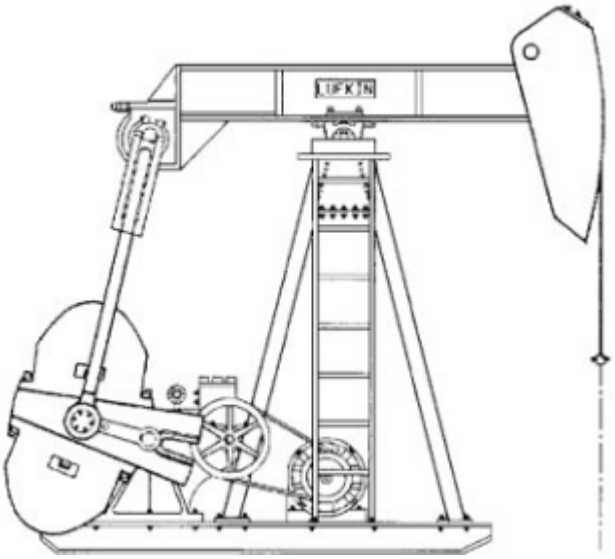
Working Drawing - Monodetail



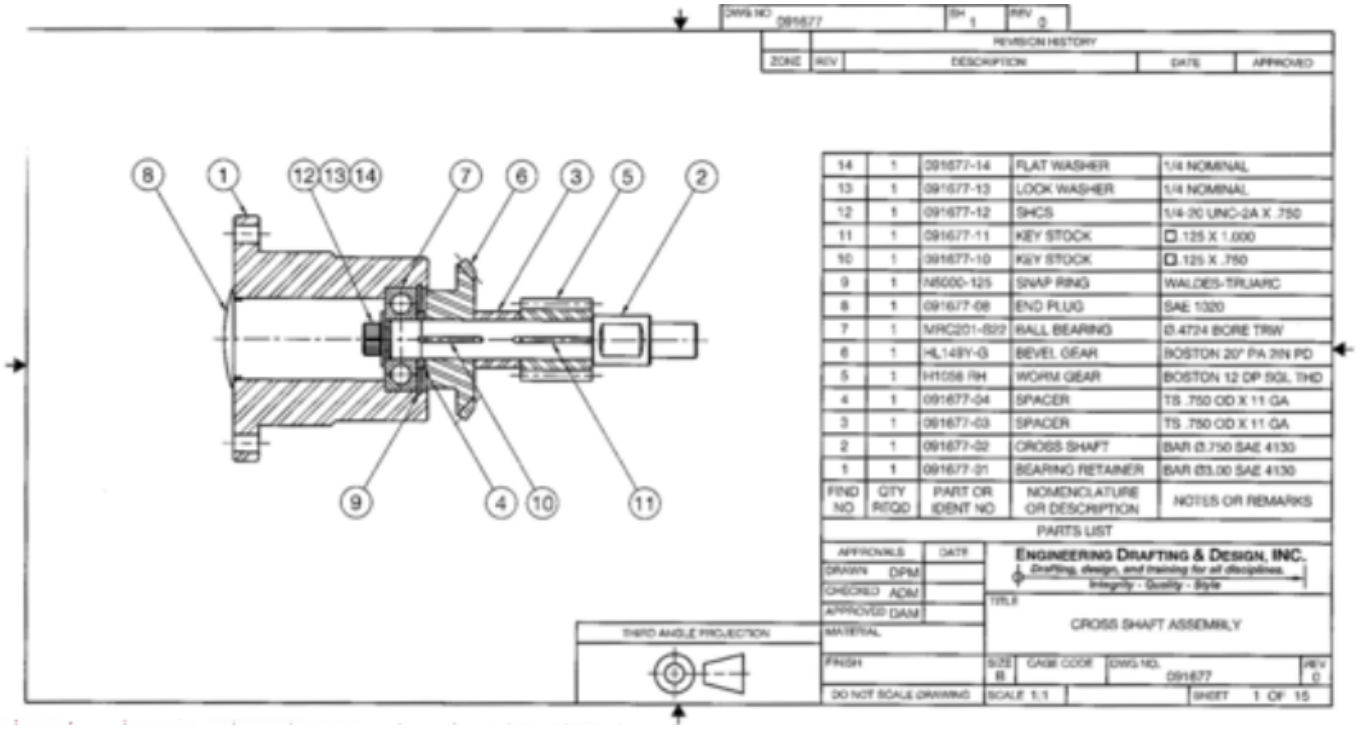
Working Drawing - Multidetail



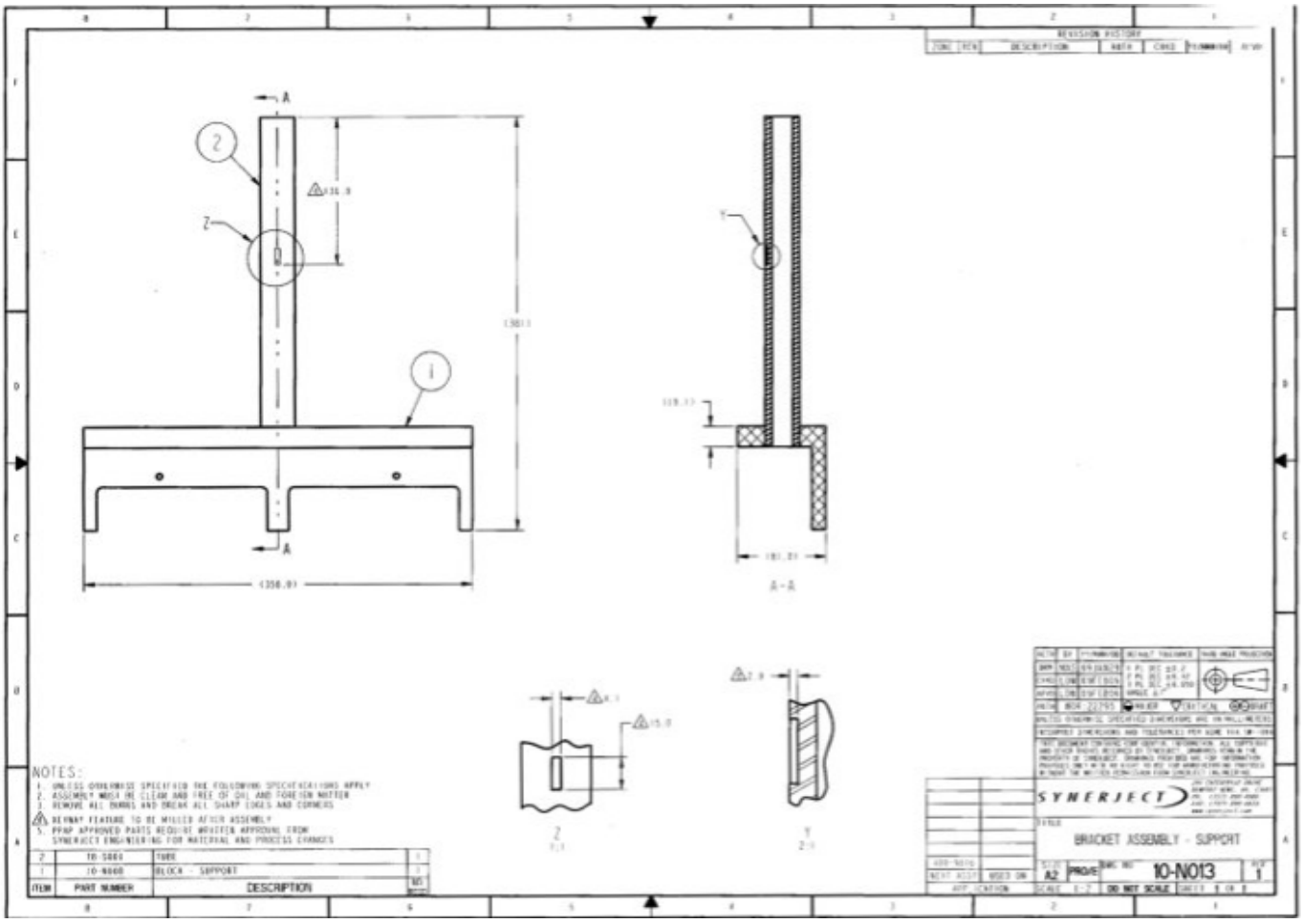
Assembly Drawing - Single View

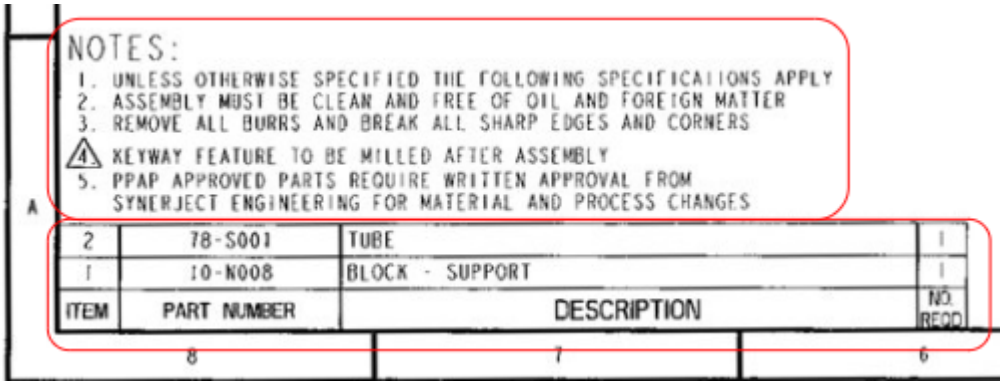


Broken-Out Assembly (Cut away)

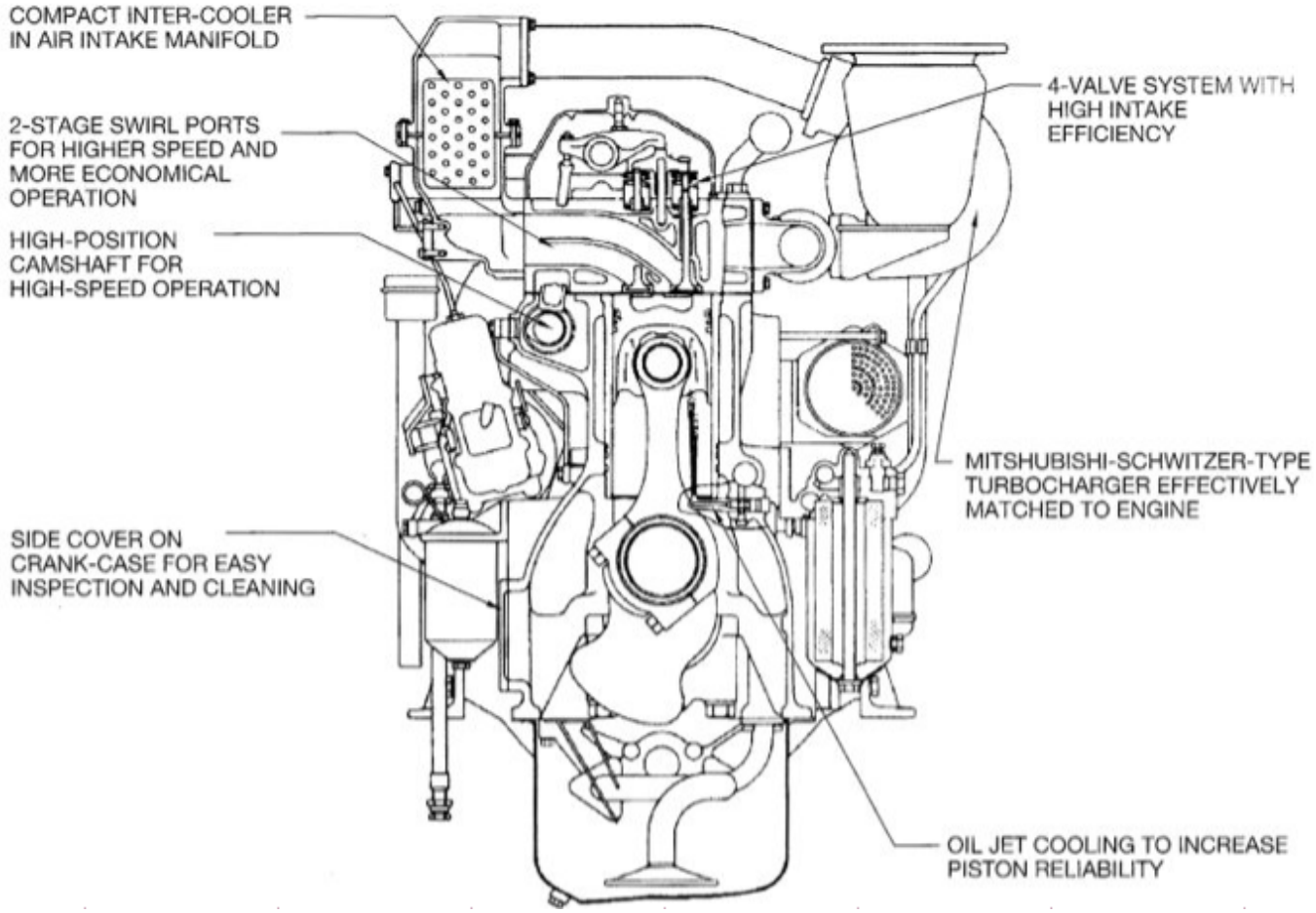


General Assembly

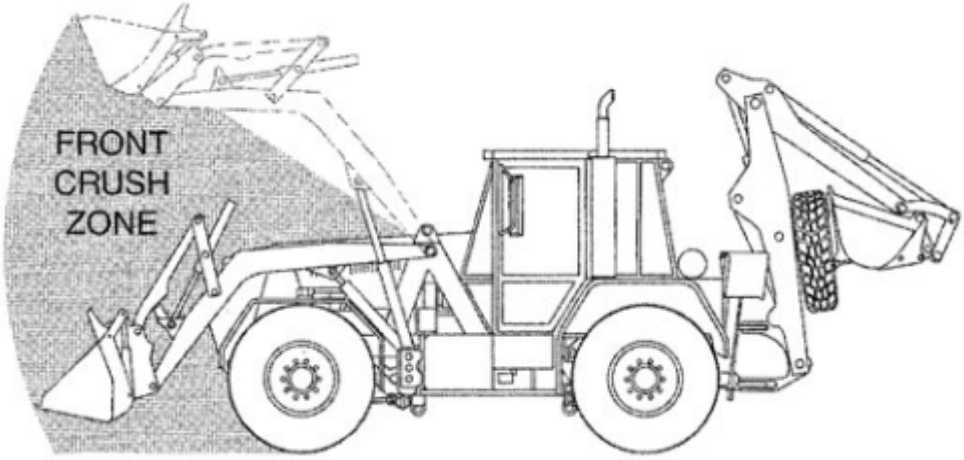




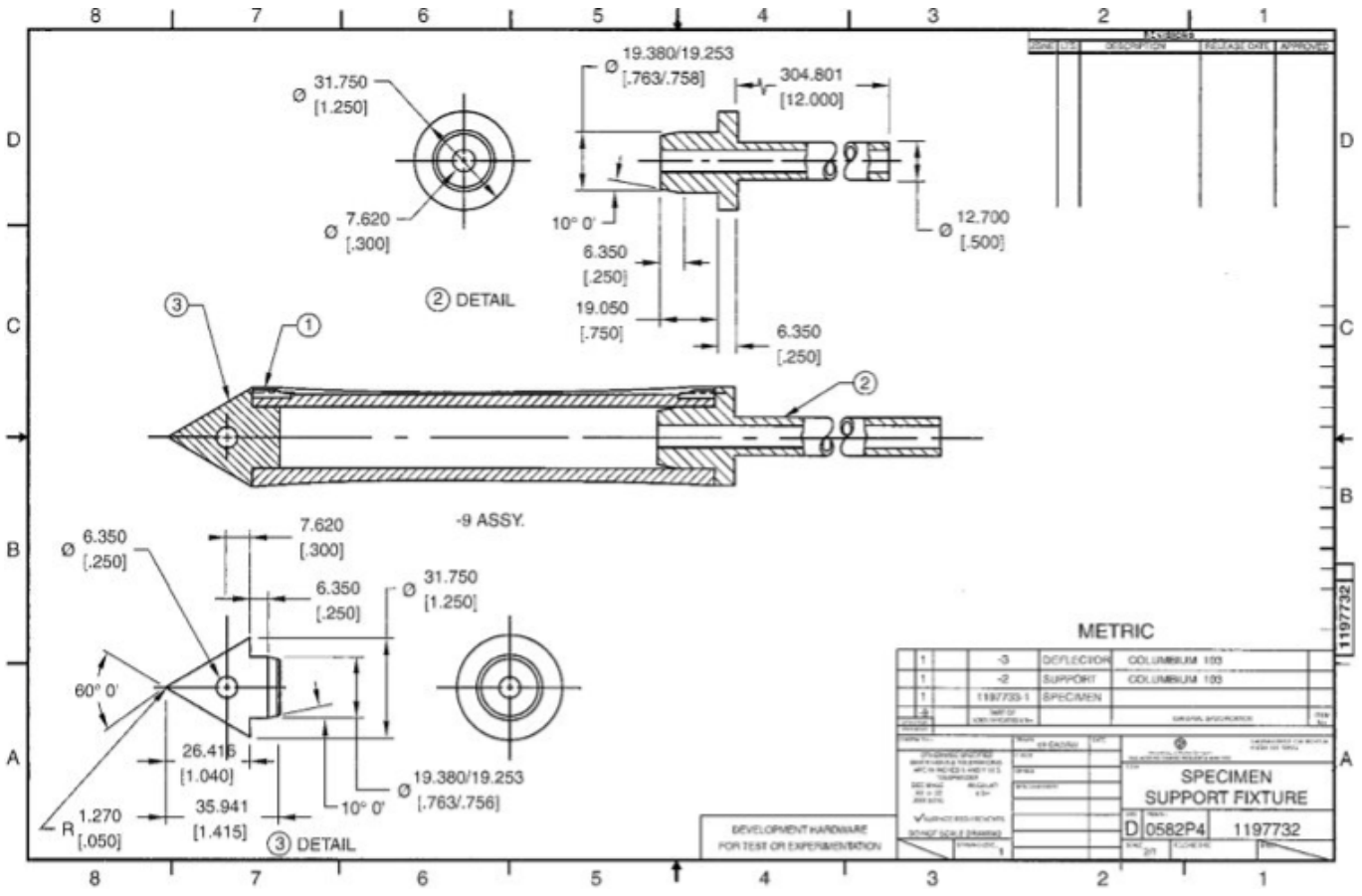
Full Section Assembly



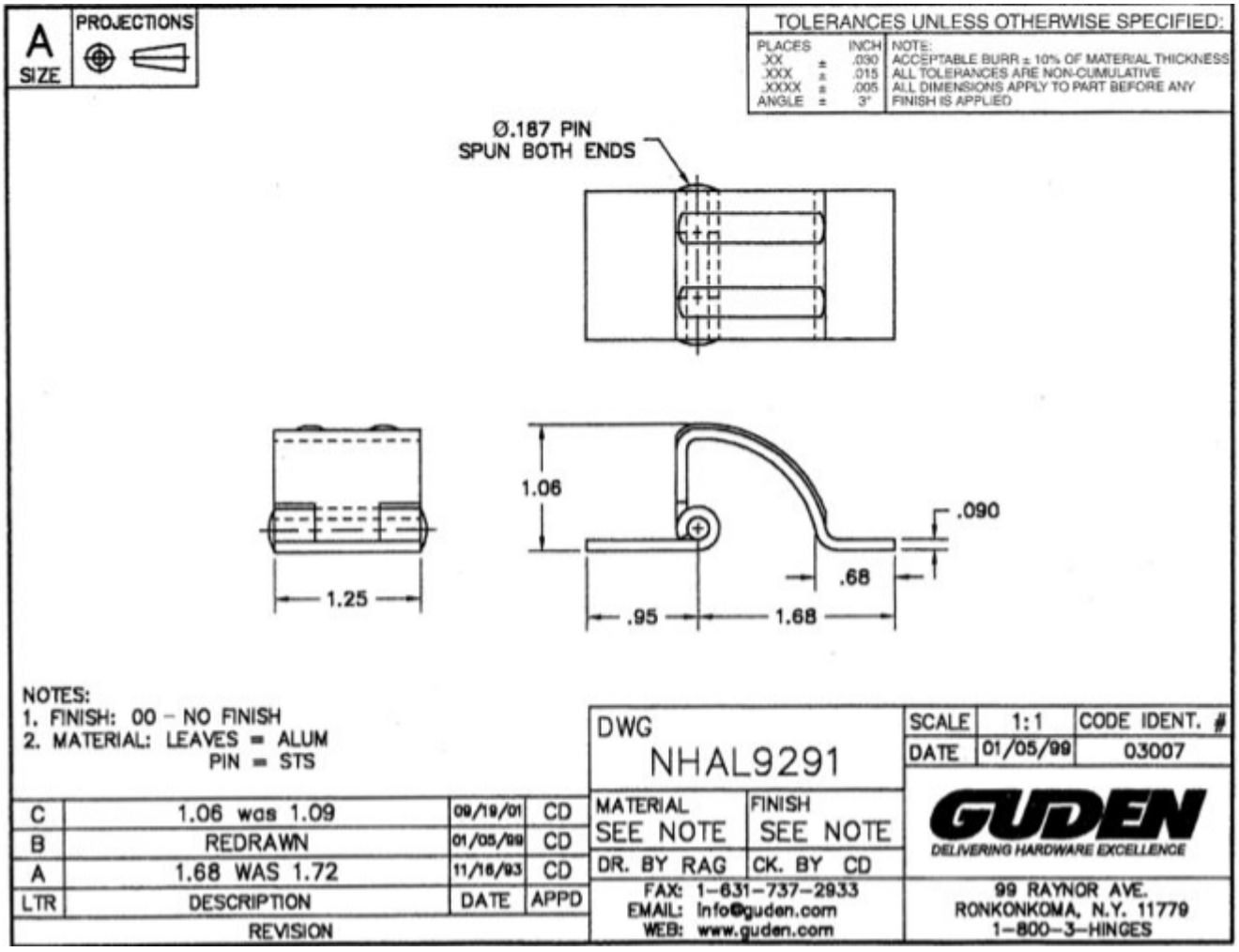
Layout Assembly



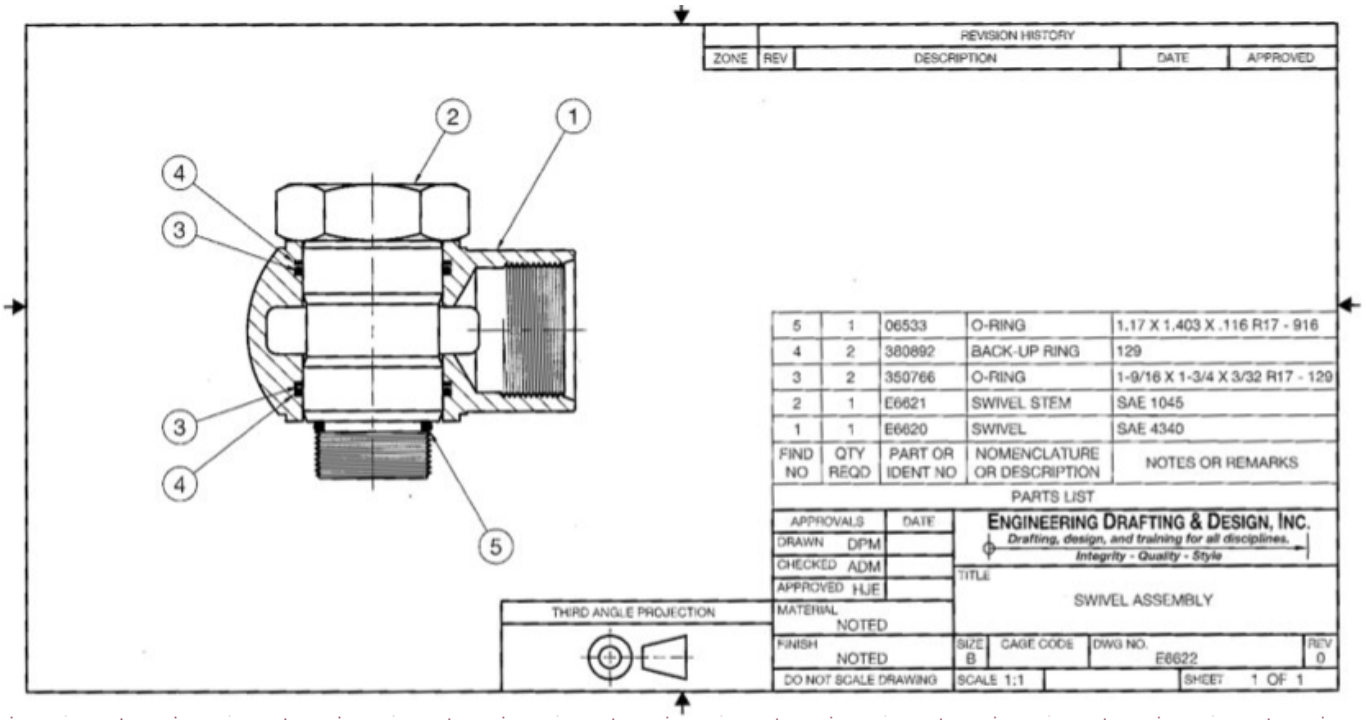
One-Off or Limited Production



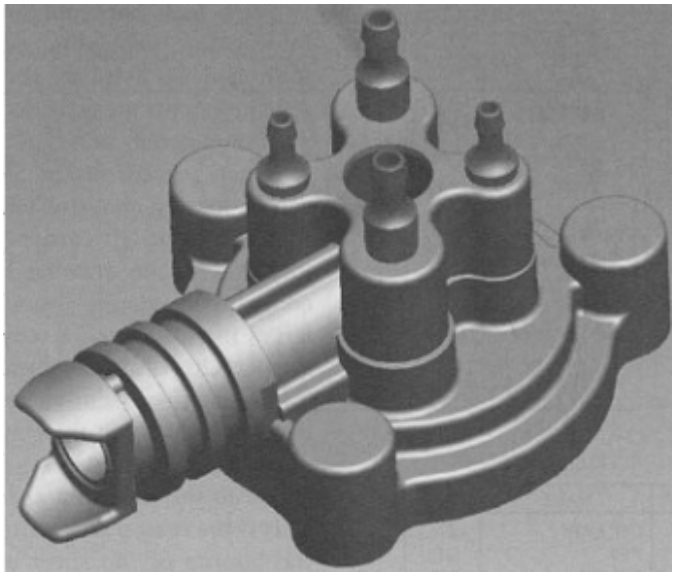
Detail Assembly



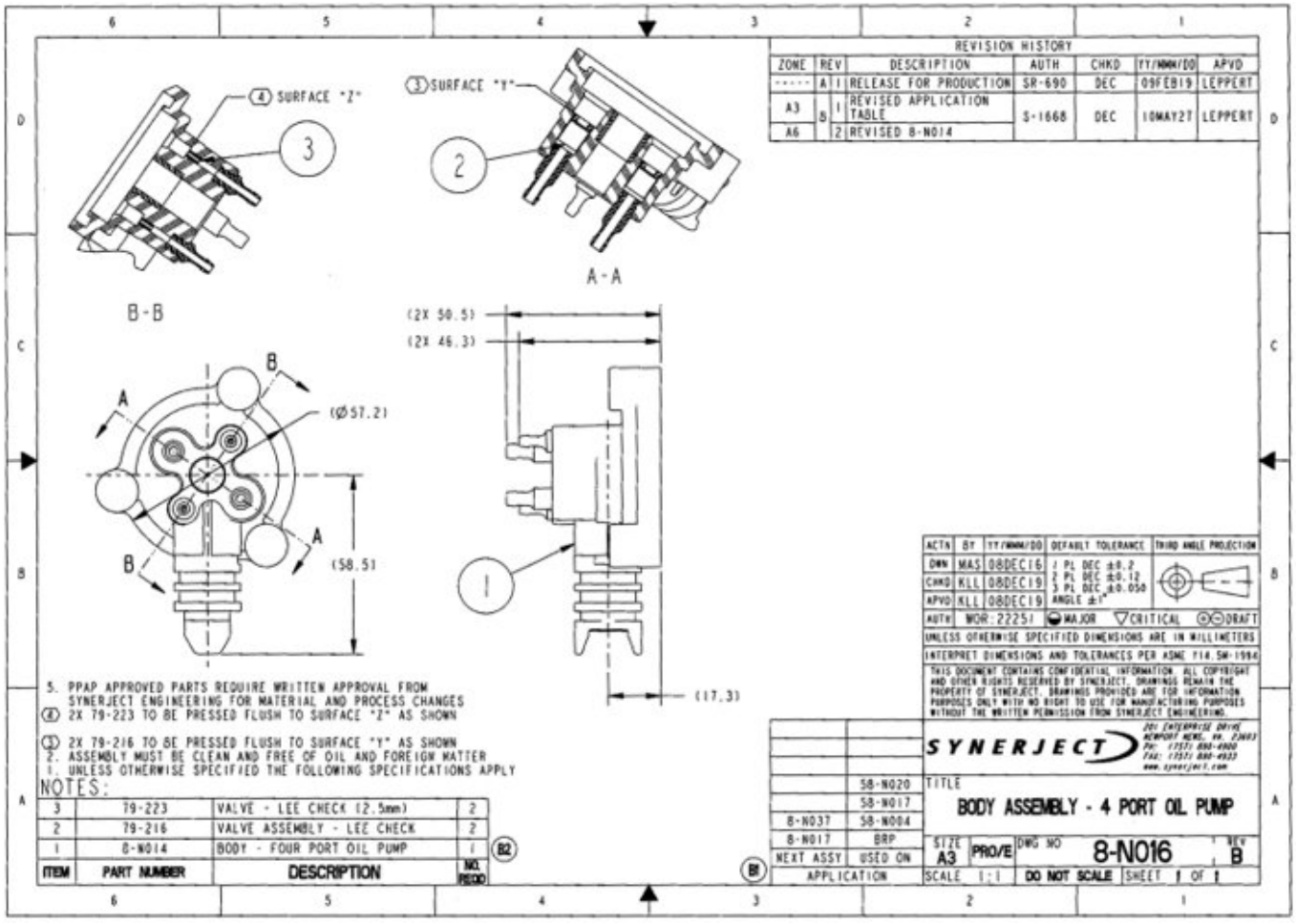
Subassembly With Parts List



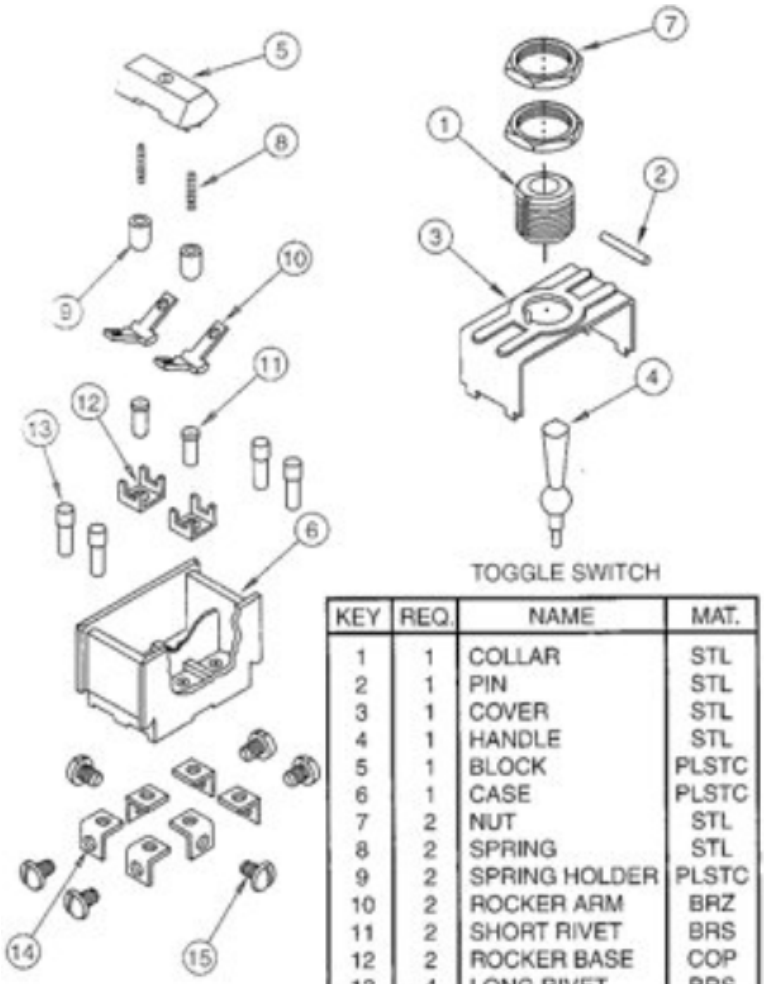
Pictorial Assembly



Matching 2D Assembly



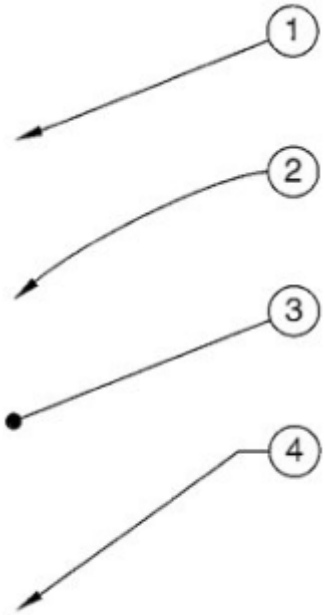
Exploded Iso



TOGGLE SWITCH

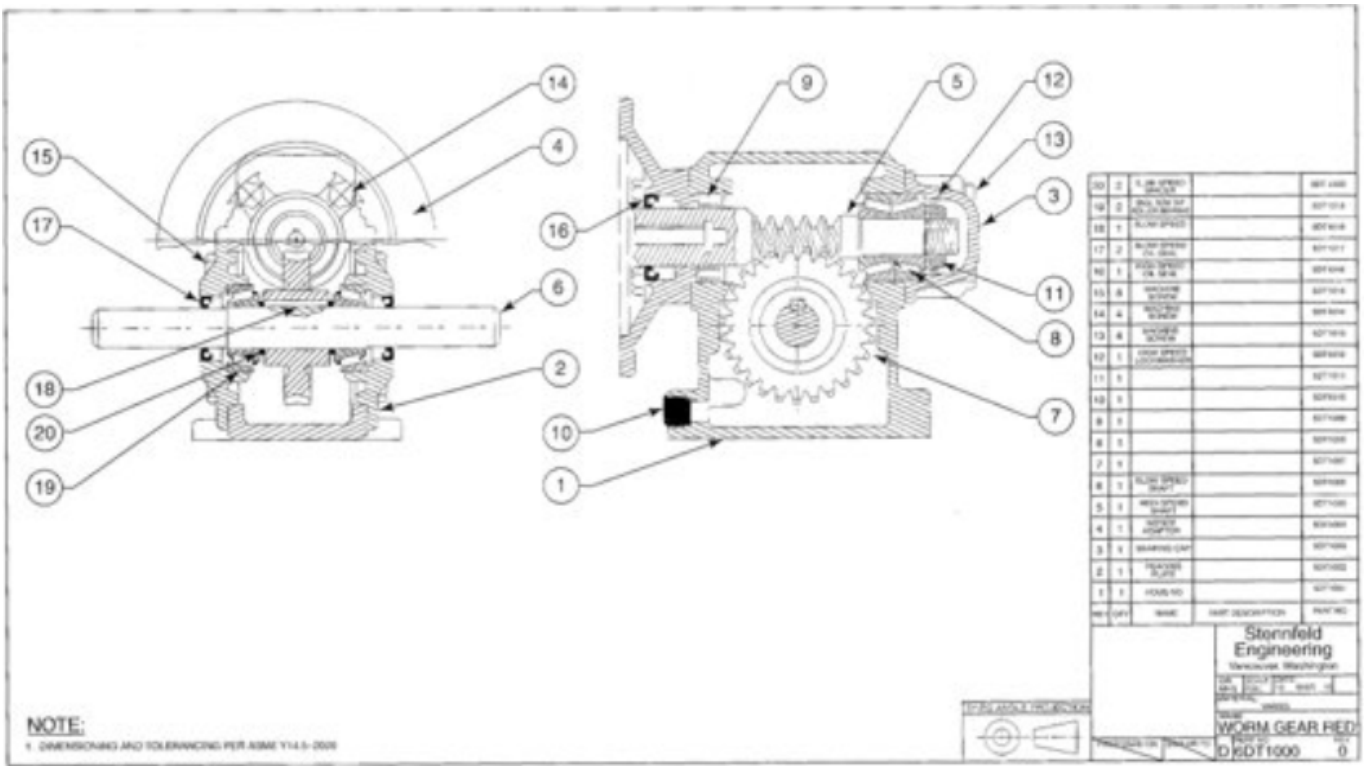
KEY	REQ.	NAME	MAT.
1	1	COLLAR	STL
2	1	PIN	STL
3	1	COVER	STL
4	1	HANDLE	STL
5	1	BLOCK	PLSTC
6	1	CASE	PLSTC
7	2	NUT	STL
8	2	SPRING	STL
9	2	SPRING HOLDER	PLSTC
10	2	ROCKER ARM	BRZ
11	2	SHORT RIVET	BRS
12	2	ROCKER BASE	COP
13	4	LONG RIVET	BRS
14	4	TERMINAL	BRZ
15	4	SCREW	BRS

Balloon Arrows



BALLOON OPTIONS

Balloon Alignment



External Parts List

ENGINEERING DRAFTING & DESIGN, INC.

Drafting, design, and training for all disciplines.

Integrity - Quality - Style

ASSEMBLY: **CRYOGENIC VALVE** ASSEMBLY NUMBER: **MSIV12-09-0087**

NUMBER OF UNITS: **250** MANAGEMENT: ____ DATE: _____

PARTS LIST

HAVE	NEED	FIND NO	QTY REQD	DIA	PART OR IDENT NO	NOMENCLATURE OR DESCRIPTION	NOTES OR REMARKS
✓		①	1		087930-01	HOUSING	
✓		②	1		087930-02	HOUSING COVER	
	✓	③	4		224707-10	3/4 X 1/4-20UNC HEX BOLT	
	✓	④	4		224707-20	3/4 FLAT WASHER	
	✓	⑤	4		224707-33	3/4 X 1/4-20UNC HEX NUT	
✓		⑥	2		224707-34	SHAFT ADAPTER	

ECN or ECO or CO

Aerojet Liquid Rocket Company

ENGINEERING CHANGE REQUEST & ANALYSIS

DATE | BORING | PAGE

ORIGINATOR NAME | DEPT | EXT | DATE | DOCUMENT NEED DATE | PROPOSED EFFECTIVITY

PART DOCUMENT NO | CURRENT REV TR | PART DOCUMENT NAME

USED ON NEXT ASSY NO | PROGRAMS AFFECTED | PROGRAMS AFFECTED

QTSS ITEM YES ____ NO ____

REQUAL REQD YES ____ NO ____

REVISE QTSS FORM YES ____ NO ____

DESCRIPTION OF CHANGE

JUSTIFICATION OF CHANGE

PROJECT ENGINEER SIGNATURE | DEPT | EXT | DATE | CCB REP SIGNATURE | DATE

DESIGN ENGINEERING TECHNICAL EVALUATION

DESIGN ENGINEER SIGNATURE | DEPT | EXT | DATE | CAUSING CONT OR WORK ORDER NO

ANY AFFECT ON	YES	NO		YES	NO		YES	NO
1 PERFORMANCE			5 WEIGHT			9 OPERATIONAL COMPUTER PROGRAMS		
2 INTERCHANGEABILITY			6 COST SCHEDULE			10 RETROFIT		
3 RELIABILITY			7 OTHER END ITEMS			11 END ITEM IDENT		
4 INTERFACE			8 SAFETY ENV			12 VENDOR CHANGE CRITICAL ITEMS ONLY		

CCB DECISION

SIGNATURES	DEPT	CCR CLR	DIS BEN
QUALITY ASSURANCE			
MANUFACTURING			
ENGINEERING			
PRODUCT SUPPORT			
MATERIAL			
TEST OPERATION			

CCB CHAIRMAN SIGNATURE | DATE | CLASS I ☐ CLASS II ☐

CUSTOMER SIGNATURE | DATE | EFFECTIVITY

Aerojet Liquid Rocket Company

ENGINEERING CHANGE REQUEST & ANALYSIS

DATE	ECRANG	PAGE

ORIGINATOR NAME	DEPT	EXT	DATE	DOCUMENT NEED DATE	PROPOSED EFFECTIVITY

PART DOCUMENT NO	CURRENT REV TR	PART DOCUMENT NAME

USED ON NEXT ASSY NO	PROGRAMS AFFECTED	PROGRAMS AFFECTED
		QTSS ITEM YES ____ NO ____ REQUAL REQD YES ____ NO ____ REVISE QTSS FORM YES ____ NO ____

DESCRIPTION OF CHANGE

JUSTIFICATION OF CHANGE

PROJECT ENGINEER SIGNATURE	DEPT	EXT	DATE	CCB REP SIGNATURE	DATE

DESIGN ENGINEERING TECHNICAL EVALUATION

PROJECT ENGINEER SIGNATURE	DEPT	EXT	DATE	CCB REP SIGNATURE	DATE

DESIGN ENGINEERING TECHNICAL EVALUATION

DESIGN ENGINEER SIGNATURE	DEPT	EXT	DATE	CAUSING CONT OR WORK ORDER NO	

ANY AFFECT ON	YES	NO		YES	NO		YES	NO
1 PERFORMANCE			5 WEIGHT			9 OPERATIONAL COMPUTER PROGRAMS		
2 INTERCHANGEABILITY			6 COST SCHEDULE			10 RETROFIT		
3 RELIABILITY			7 OTHER END ITEMS			11 END ITEM IDENT		
4 INTERFACE			8 SAFETY EMI			12 VENDOR CHANGE CRITICAL ITEMS ONLY		

CCB DECISION

SIGNATURES	DEPT	CONCUR	DISSENT
QUALITY ASSURANCE			
MANUFACTURING			
ENGINEERING			
PRODUCT SUPPORT			
MATERIAL			
TEST OPERATION			

CCB CHAIRMAN SIGNATURE	DATE	CLASS I ☐ CLASS II ☐
CUSTOMER SIGNATURE	DATE	EFFECTIVITY

References

Credits:

- Unless indicated otherwise all images are from Madsen, David A., and David P. Madsen. Print Reading for Engineering and Manufacturing Technology. Clifton Park, NY: Delmar, Cengage Learning, 2013. Print.

Blueprint Reading - 2D Models versus 3D Models

2D Models

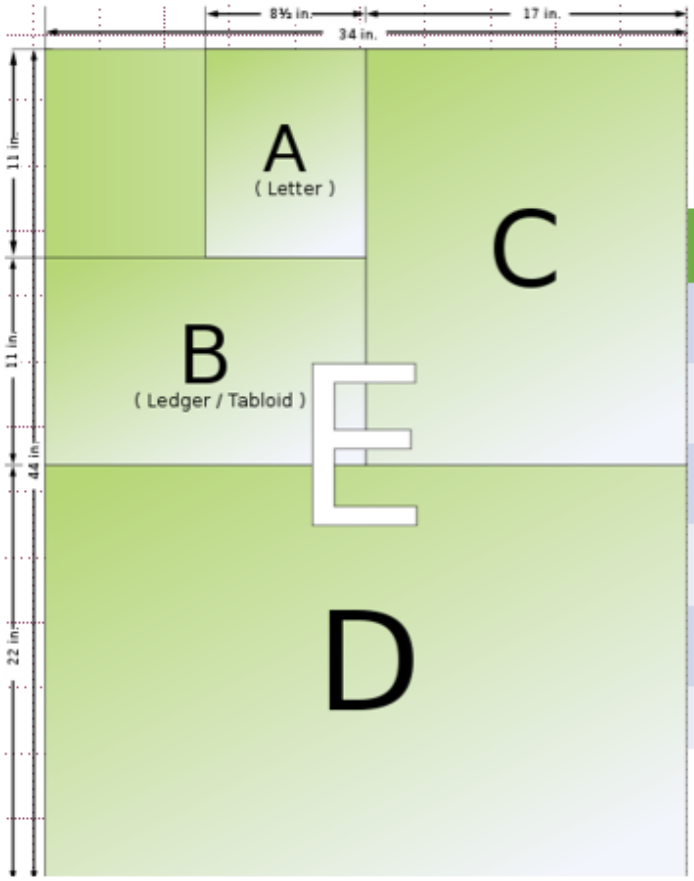
- Drawn on paper or in CADD
- Accurate in 2 dimensions
- Most common way of representation
- Does not convey volume or depth
- Good for manufacturing

3D Models

- Drawn in CADD
- Accurate in 3 dimensions
- Most visual method of representation
- Can give volume and weight of object
- Can show parts interacting in motion
- Good for design

Blueprint Reading - Parts of a Drawing

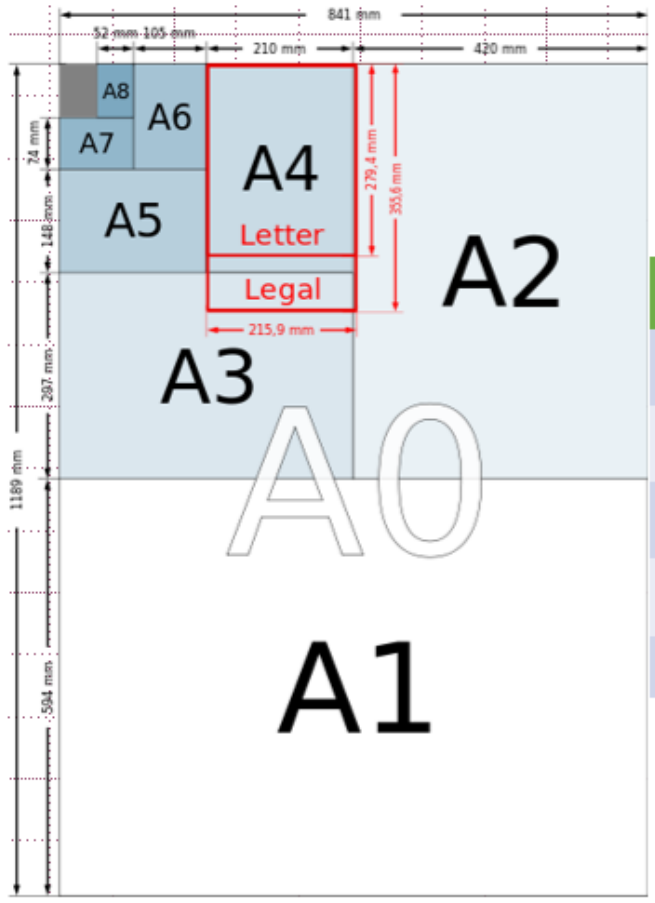
Common Drawing Sizes - Inch



Letter	Size in Inches
A	8.5” x 11”
B	11” x 17”
C	17” x 22”
D	22” x 34”
E	34” x 44”
F	28” x 40”

Common Drawing Sizes - Inch

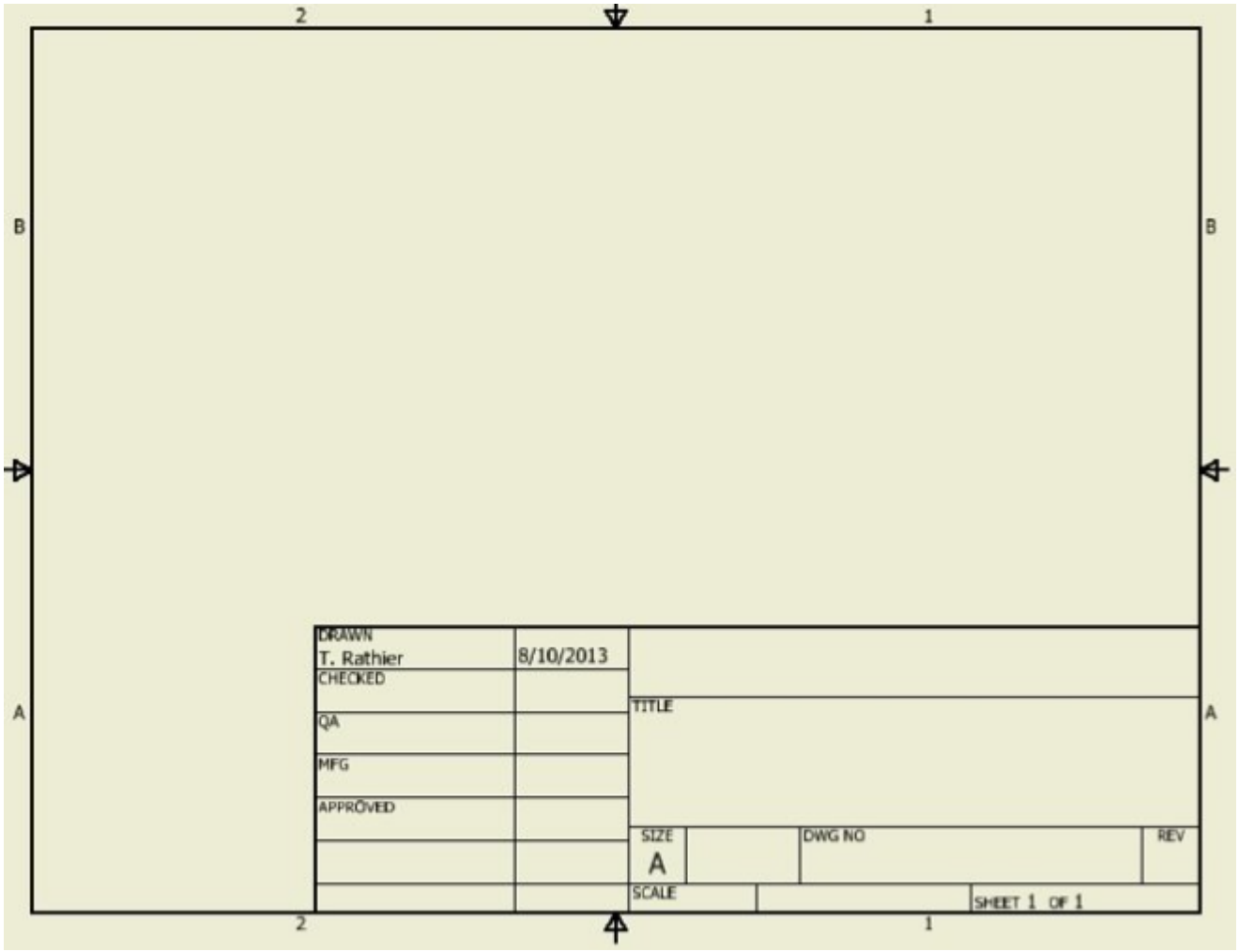
Common Drawing Sizes - MM



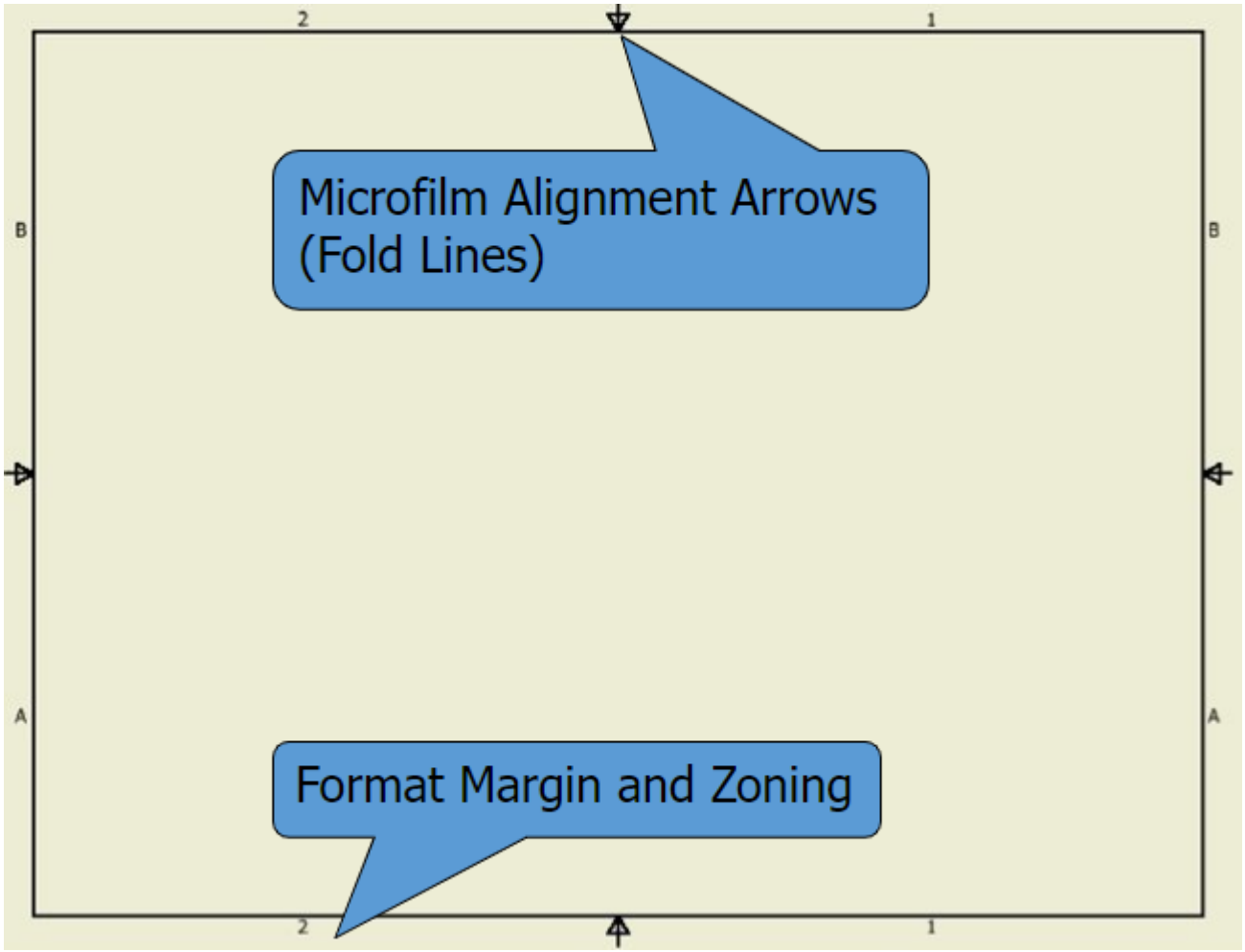
Letter	Size in Inches
A0	84mm x 1189mm
A1	594mm x 841mm
A2	420mm x 594mm
A3	297mm x 420mm
A4	210mm x 297mm

(A5 thru A8 are not common)

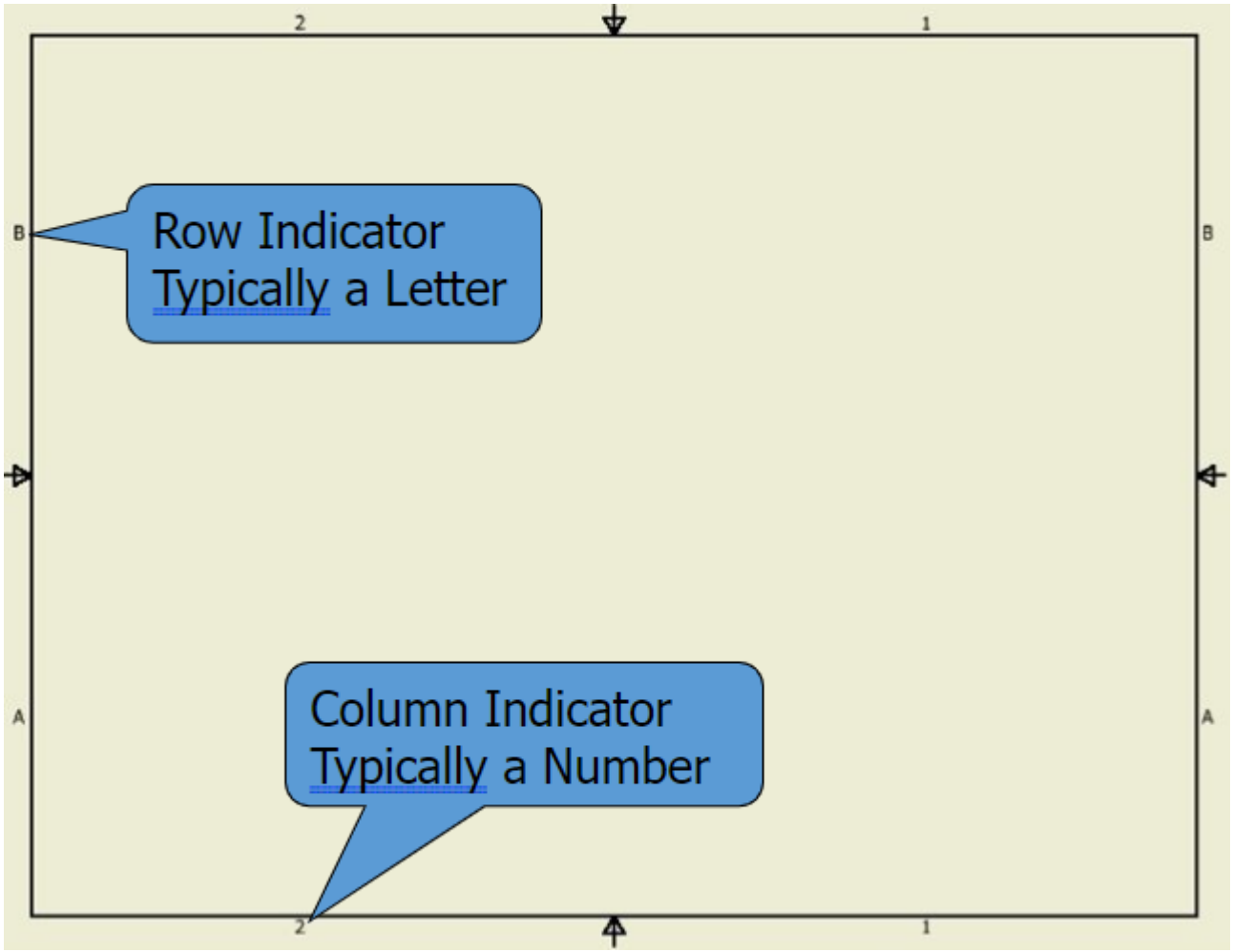
Common Drawing Sizes - MM



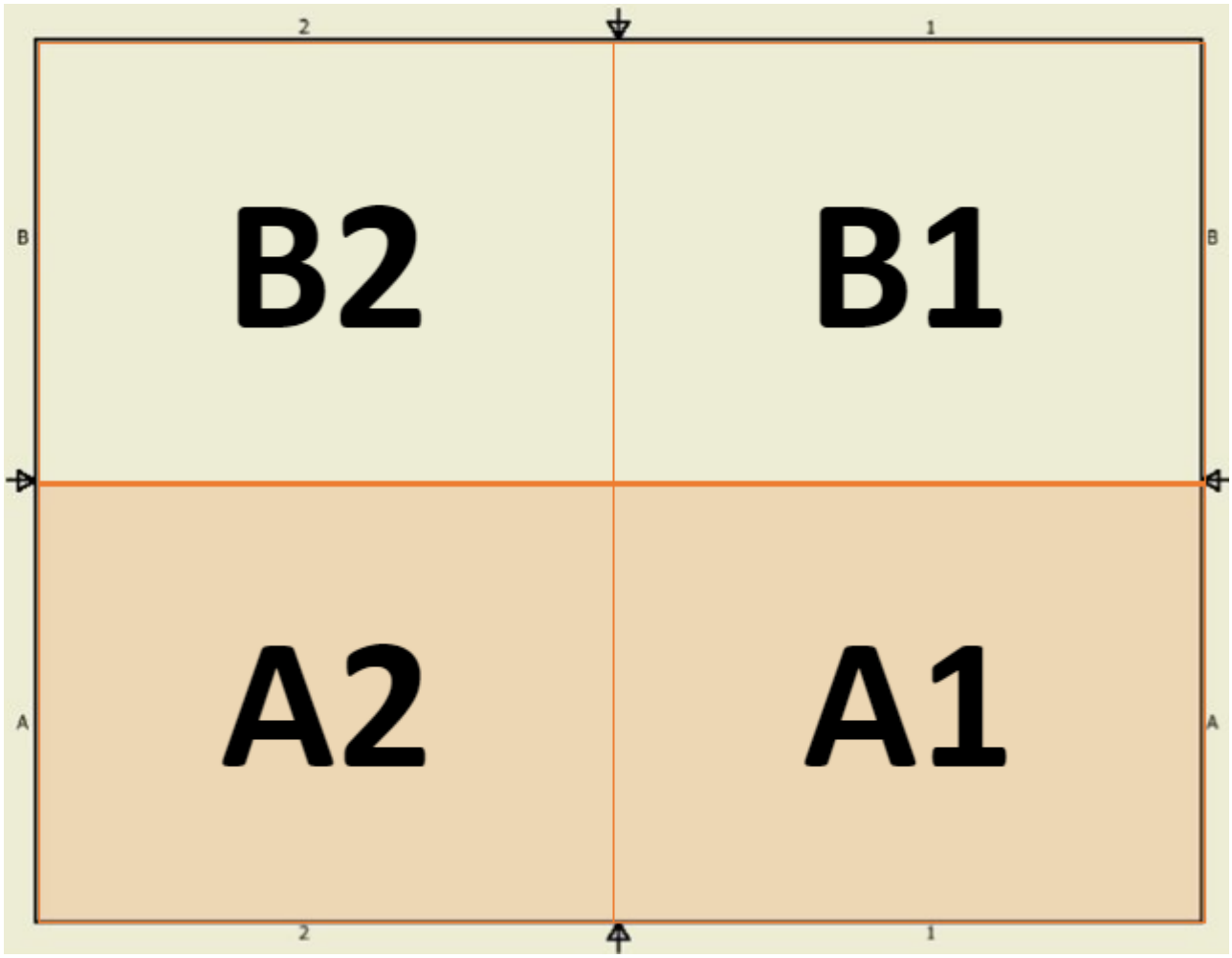
Basic Drawing



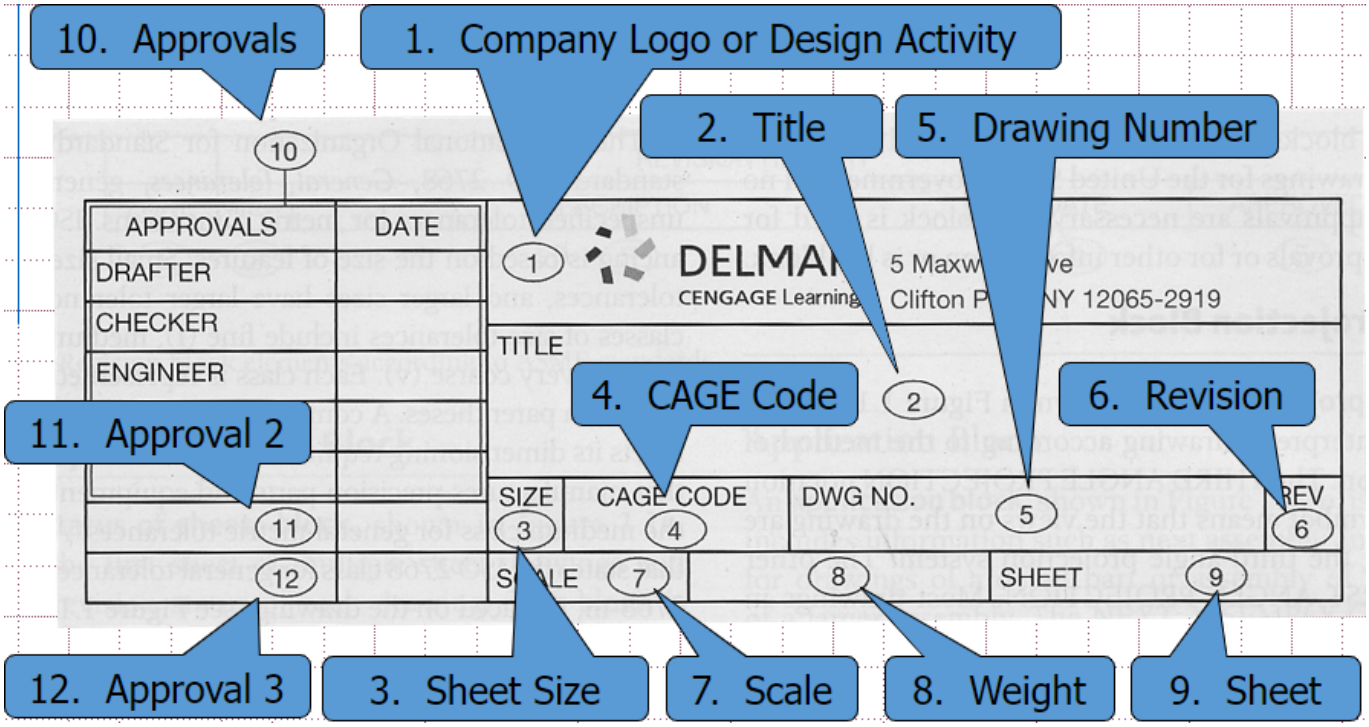
Border



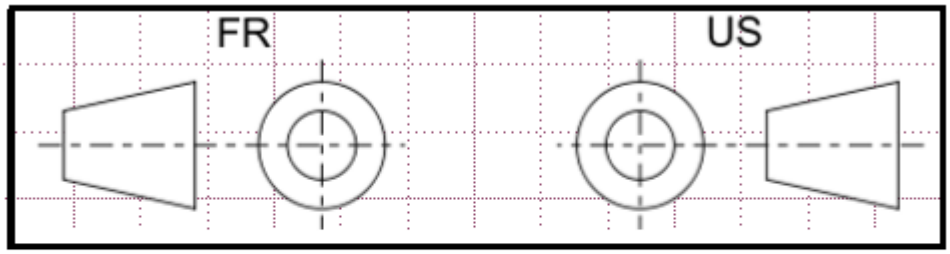
Zoning

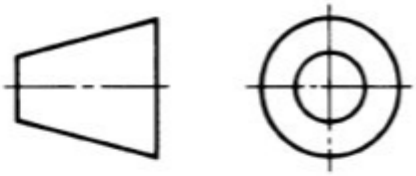
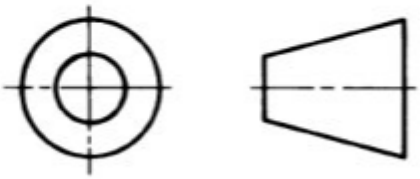


Zoning #2



Title Block - ASME Standard



Projection	Symbol
First angle	
Third angle	

Angle of Projection

TOLERANCES ON:	
HOLE DIAMETERS	±.003
.XX	±.030
.XXX	±.005
ANGLES	±1°

Original Title Block

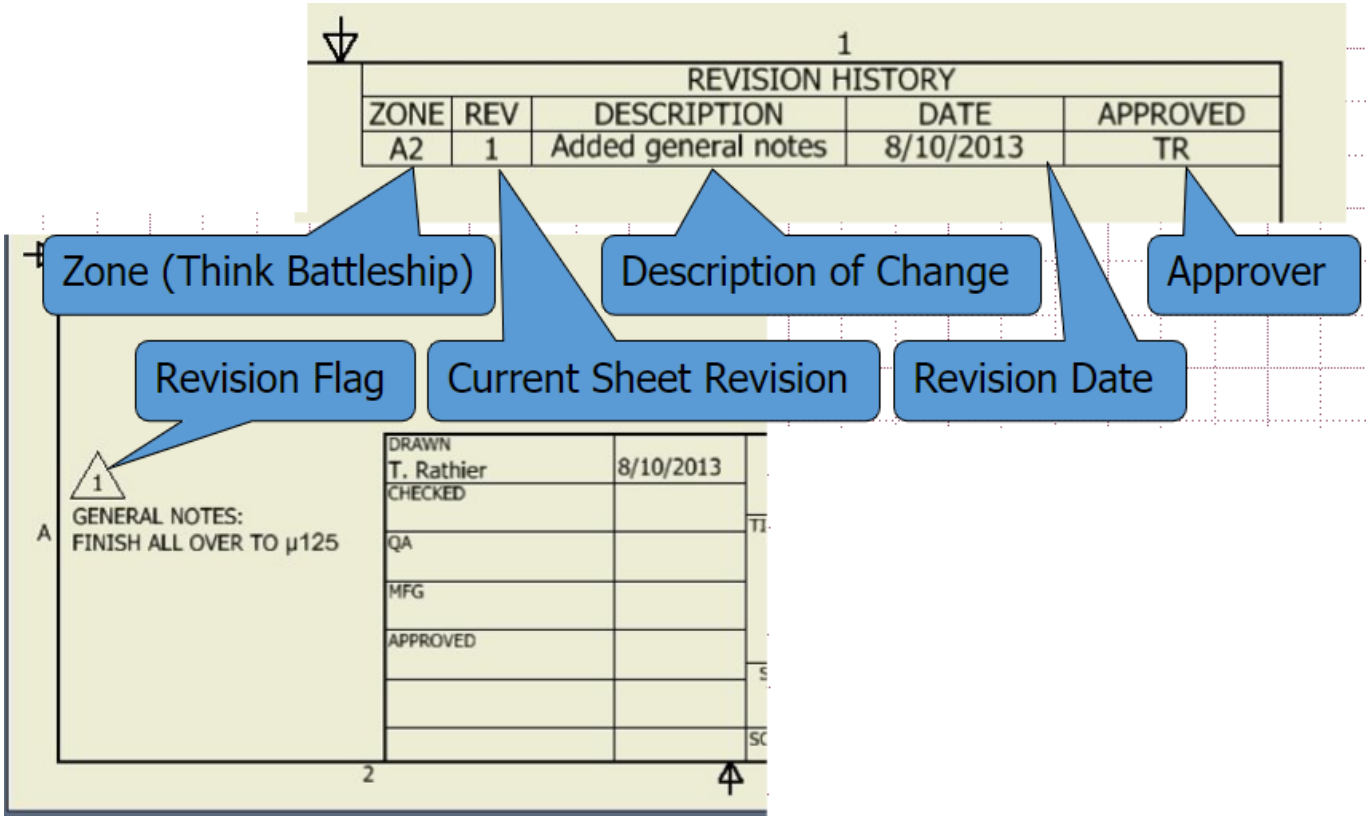
TOLERANCES	
.000 < X < .249	±.002
.250 < X < .499	±.004
.500 < X < .999	±.006
1.000 < X	±.010
HOLE DIAMETERS	±.004
HOLE CENTERS	±.003
CHAMFERS, FILLETS	±.005
COUNTERBORES, COUNTERSINKS	±.005
ANGLES	±.5°

New Title Block

UNLESS OTHERWISE SPECIFIED:	
WHOLE NUMBER DIM'S:	± 1
ONE PLACE DECIMALS:	± 0.5
TWO PLACE DECIMALS:	± 0.15
ANGLES:	±0.5°

Dimensioning and Tolerance Block

Revisions



Revisions

Revision Status of Sheets

0	0	C	A	C	REV	REV STATUS
5	4	3	2	1	SH	

HORIZONTAL SHEET BLOCK

REV STATUS	
REV	SH
C	1
A	2
C	3
0	4
0	5

VERTICAL SHEET BLOCK

References

Credits:

Unless indicated otherwise all images are from Madsen, David A., and David P. Madsen. Print Reading for Engineering and Manufacturing Technology. Clifton Park, NY:
Delmar, Cengage Learning, 2013. Print.

Textbook Reading:

Tramming the Head - 10 Pages

Videos:

How to Tram a Milling Machine - 7 Minutes

Climb Milling vs Conventional Milling - 19 Minutes.

Week 2: Manufacturing Process Review

Concept Goals:

By the end of this week, you should:

- List reasons why threading is important to machining (SLO 2, SLO 3)
- Explain why tolerances are important to machining (SLO 1, SLO 2)

Concept Content:

This week we will continue reviewing manufacutring processes. We are going to look through processes you will be utilizing in your projects this semester.

This week's material:

Reading:

Protolabs. (n.d.). *Understanding CNC machining tolerances*. Protolabs. https://www.protolabs.com/resources/design-tips/fine-tuning-tolerances-for-cnc-machined-parts/

Palmer, S. (2022, July 16). *Threading on a Lathe*. Modern Machine Shop. https://www.mmsonline.com/articles/threading-on-a-lathe

Lathe Threading - 11 Slides

Videos:

Here is a good example of the magic of proper tolerances: Tolerance Example Video - YouTube Short

Basics of Tap and Die Sets - 9 Minutes

How to Use a Tap and Die Set - 9 Minutes

Engaging a Half Nut - 15 Minutes

How To Cut Threads on a Lathe Machine - 20 Minutes

How to Cut Threads on a Lathe - 20 Minutes

Assignment:

Week 2 Quiz - 5 Questions

Week 3: Material

Concept Goals:

By the end of this week, you should:

- Perform surface grinding (SLO 2)

- Perform cuts using a bandsaw (SLO 1)

Concept Content:

This week we will discuss how to make cuts with a bandsaw and how to perform surface grinding. Both of these are skills you will need when you go into industry.

This week's material:

Textbook reading:

Bandsaw - 12 Pages

Surface Grinding - 11 Pages

Videos:

Cutting Round Stock on a Bandsaw Tutorial - 11.5 Minutes

Understanding Grinding - 27 Minutes

Assignment:

Week 3 Quiz - 5 Questions - Located under assignments. Look in the Quiz tab.

Unit 2 - Projects (Weeks 4-14)

Unit 2 Outline

Concept Goals:

- Demonstrate the ability to read and understand blueprints in order to create machining projects (SLO 1, SLO 2, SLO 3)
- Demonstrate the basic manufacturing skills needed to complete various machining projects (SLO 1, SLO 2, SLO 3)

Concept Content:

Instructor Note: For this unit you can assign the projects as needed among the students. The next module over will have a bank of projects for you to pick and choose from. Given

how students will move at their own pace, there are some more advanced projects in there for those who have the time. You will be responsible for selecting which projects to work on for each student in the order that makes the most sense for them.

This section will have learning materials related to the various projects and what students will be learning from them. There are here in a bank for you to go through with the students as they make sense.

Welcome students to the second part of this class. With the first few weeks of review complete, it is time to work on projects. From here to the end of the semester, we will be tackling various projects in class. They are projects for both the mill and the lathe machines. As there are not enough of either machine for all students to work on a singular project, you will each be assigned projects to work on individually. Some may start with a lathe project, some may start on the mill. This will be at my discretion.

Below are materials related to the projects we will be doing in class. This is meant to supplement and expand upon what you are doing by hand in the classroom. These will be assigned as you are working on the relevant projects.

Video:

Drilling and Tapping in a Circular Bolt Pattern - 20 Minutes - This is a similar project and showcases the same techniques and concepts you will be using for this project.

Project Resources:

Puzzle Solution - After milling all of your parts, go ahead and put your puzzle together.

Captive Nut Puzzle

Optional Assignments: **(Instructor note: there is a bank of assignments you can use throughout the semester for this unit)**

Lathe Project 1 Assignment - Find a piece of scrap material in the shop for this project. Print the assignment and provide the required information.

Unit 2 Projects

Concept Content:

Here are the blueprints for machining projects for this course. **(Instructor note: this is a bank of potential projects, you can pick and choose which ones you like. There are more projects there than most students would be able to do in one semester).**

Your instructor will assign the projects from this bank of projects.

Blueprint:

Bolt Circle Refresher Project

Puzzle Drawing Packet

Lathe Project 1 Blueprint

Captive Nut Male Model

Captive Nut Female Model

Machinist Vise Project

Milling Project 4

VEE-Blocks

Clamp Stop

Air Engine

Unit 3 - Final Exam (Weeks 15 and 16 If Needed)

15.1 Final Exam

Concept Goals:

Outline the learning goals for this module here.

Concept Content:

This week we will have our final exam. This exam covers the topics we covered in this course through the projects and the textbook chapters and video content. Please open up the exam under the assignments tab. It will be in the test section.

This Week's Assignment:

Final Exam - TBD Questions **(Instructor Note: You can set the number of questions you'd like, you do not have to use all 40 in the exam question bank)**

15.2 Course Wrap-Up

Concept Content:

With the completion of the final exam, you are finished with this course! Please make sure you have completed any unfinished projects before the end of the week as well.

Thank you for your persistence through the course. I hope it has been a fun course for you this semester as we have been going through all of our various projects.