

# 5

## Layout Techniques

### Objectives


The learner will be able to:

- Describe layout and its uses
- Compare and contrast precision and semi-precision layout instruments
- List steps to perform layout procedures
- Apply simple mathematics for layout

### Orienting Questions

- ✓ What is layout?
- ✓ Is layout useful in today's machining industry?
- ✓ Can layout produce a precise representation of the part?

### Helpful Tips

- ✓ You can select the **HIGHLIGHTED TERMS** to read more about it.
- ✓ If needed, there are **CLOSED CAPTION** buttons  on the YouTube videos that will enable you to read along while you watch. The Closed Caption buttons are located bottom right of the video screen.
- ✓ Take time and explore about the subject by selecting the **EXPLORE** links in each section of this module.



## INTRODUCTION

**LAYOUT** can be defined as a pre-machining operation that will produce a template by scratching lines in raw or finished material. The “scratched lines” are referred to in the machining world as scribed lines. Precisely placed lines form a picture that will aid the machinist in visualizing the part.

Layout defines locations, special contours, and features of a part. Machinists can use layout lines as guide marks for machining however, producing special shapes can be difficult if CNC equipment is not available. Layout proves to be a useful Job-Shop skill when tolerances are not critical and time is limited.

The layout process can be classified as semi precision and precision. Semi-precision layout is generally accomplished with simple tools where tolerances are not tight. Precision layout is performed through the use of measuring tools that discriminate .001in. or finer.

### General Guidelines for Layout

- Study the blueprint, developing a plan of steps and tools that will help accomplish the layout procedure.
- Pay close attention to tolerances.
- Be sure to deburr the material and apply the layout fluid properly.
- Determine if the lines to be scribed are originating from a referenced edge or a baseline. These are the surfaces where all of the measurements are taken from.
- Layout all center points for circles and arcs, lightly marking their center points with a prick punch.
- Scribe any circles and/or arcs.
- Scribe angular and tangent lines.
- Scribe any remaining lines to connect points that are left.

**EXPLORE:** [Layout](#) ← Click this link to learn more

## SEMI-PRECISION LAYOUT TOOLS

Semi-precision layout tools are used when great accuracy is not required. These tools, in some cases, only provide representations of the features that are laid out. Radius



gages are an example of a semi-precision tool. They provide a depiction of what size a radius scribed on a part should look like.

## COMBINATION SET

The **Combination Set** (see Figure 1) is a common tool that is used in basic layout. It consists of a blade, square head, center head, and protractor. The components have clamping screws that enable them to be clamped onto the blade. When the square head is attached to the blade it forms a 90° angle. The center head can be used in combination with the blade to find the center of round material. The protractor, when mounted to the blade can be used to scribe angles within 180°.

### EXPLORE: What is a Combination Set?



**Figure 1: Combination Set** (Image by Ladell Humphries, 2013)

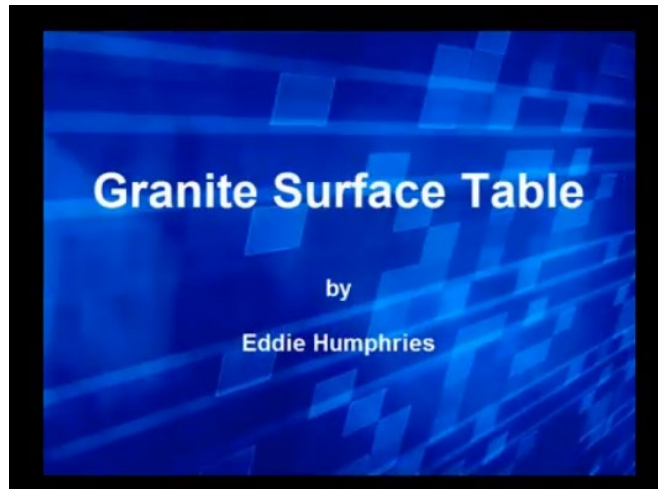
## SURFACE PLATES

**SURFACE PLATES** are the essential tool in layout. Originally made of cast iron, the **SURFACE PLATE** acts as the base from which the lines originate and simulate a perfectly flat surface (see Figure 2). Cast iron surface plates proved to be unreliable

when compared to granite. Granite is denser, harder, has less internal stress, and is impervious to water. Granite also possesses the quality for better temperature stabilization. Temperature can effect measurements taken. Greater care must be considered when using this surface plate. While granite is dense and hard, it is also still brittle. Easily chipped, great care should be taken when using granite surface plates. Granite surface plates are classified into three grades:

- AA, lab grade, +/- 25 millionths inch
- A, Inspection grade, +/- 50 millionths inch
- B, Shop grade, +/- 100 millionths inch

### EXPLORE: Surface Plate



**Figure 2: Granite Surface Table** (video by Eddie Humphries, YouTube, 2013)

### LAYOUT DYE

**LAYOUT DYES** provide a backdrop on the steel that will help in seeing the lines that are being scribed. The dyes come in a variety of colors including red, blue, and white. Blue dyes being the most common (**see Figure 3**). The color of dye is dependent on the surface color of the material. Layout dye should be applied sparingly and in an even coat. Layout dye is usually applied with a brush applicator or as an aerosol spray. It is important to remember that if the coat of layout dye is too thick, the lines that are scribed will look fuzzy and the dye can tear or peel away from the scribed edges (**see Figure 4**).



## EXPLORE: Layout Dye Explained

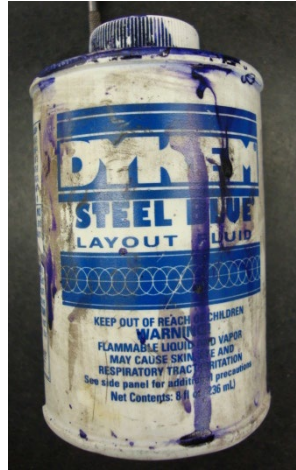


Figure 3: Example of a Layout Dye (Image by Ladell Humphries, 2013)

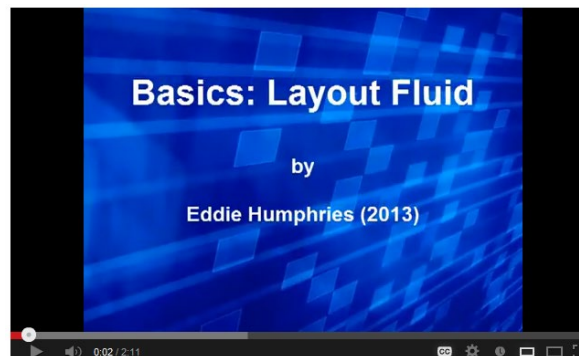


Figure 4: How to Apply Layout Fluid (video by Ladell Humphries, YouTube, 2013)

## SCRIBERS & DIVIDERS

In order to scratch lines in metal, tools with very sharp points called **SCRIBERS** (see **Figure 5**) are used. There are **three types** of scribers that are common: The pocket scriber, engineer's scriber, and the machinist's scriber.



- Pocket scribe – Has a removable tip that can be removed and stored in the handle for safety.
- Engineer's scribe – Has one straight end and one hooked end. The hook end permits easier access to the line being scribed.
- Machinist's scribe – Has only one fixed end.

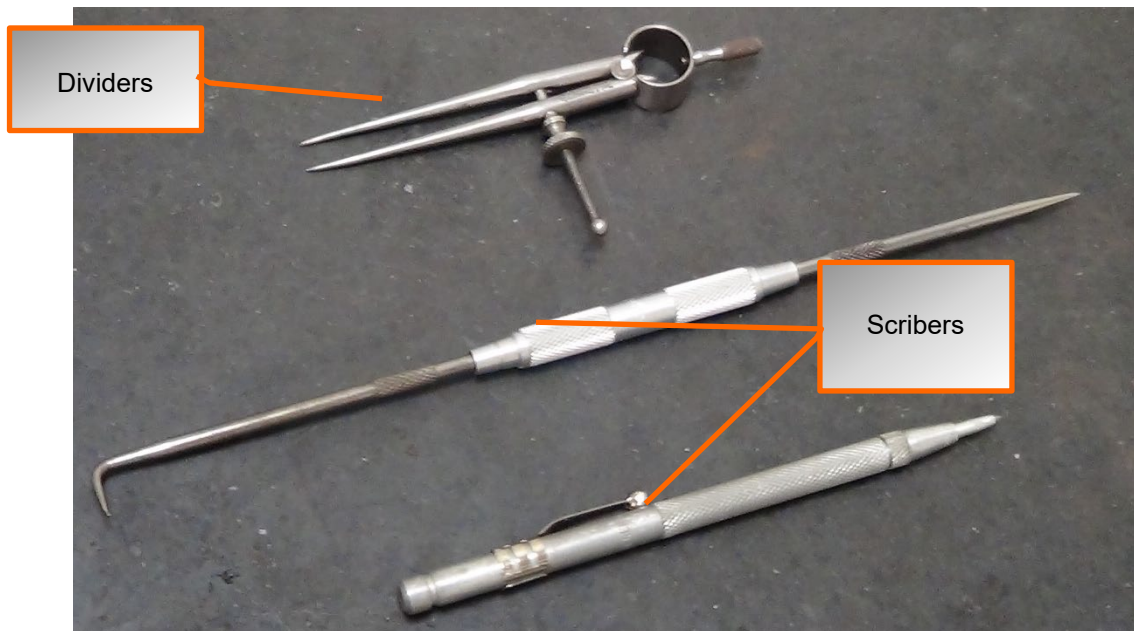
Most scribing is done with a straight edge. A straight edge is as simple as a straight piece of material but a ruler is most commonly used. The straight edge allows the scribe to create the straight line. When scribing against a ruler: hold the ruler firmly and tilt the scribe away from the ruler, so that the tip of the scribe can accurately mark as close to the ruler as possible.

**DIVIDERS** or **SPRING CALIPERS** (see Figure 3) provide the means so that a machinist can scribe radii bigger than what can be provided in a standard radius gage set. Spring calipers range in size from 2 to 12 inches, the measure of the maximum radius that can be scribed, and have 2 sharpened points with one side being longer than the other. The longer side is inserted into the point made with a punch. Dividers and spring calipers are set to a ruler. Rulers that are used in layout have engraved markings that are more accurate than rulers that have printed markings.

### EXPLORE: Dividers Explained







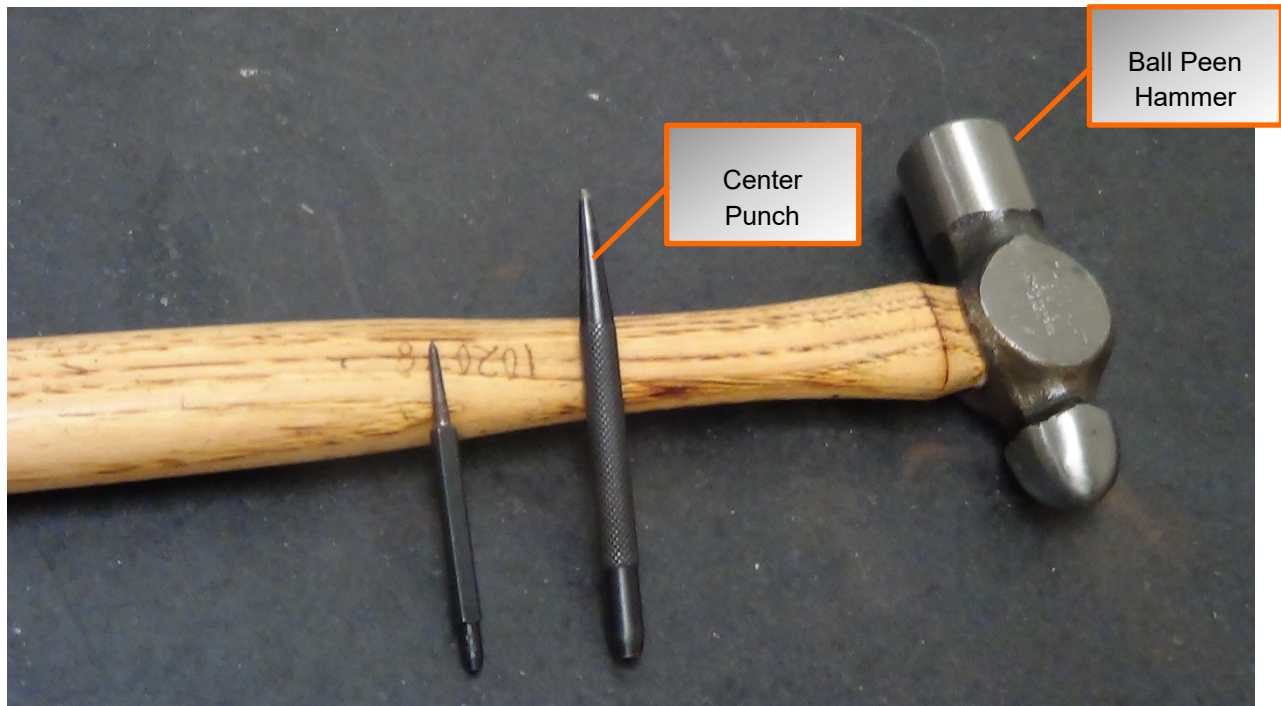
**Figure 5: Image of a Divider and Scribes** (Image by Ladell Humphries, 2013)

### 1.1.1. HAMMERS AND PUNCHES

**BALL PEEN HAMMERS** (see Figure 6) are used in layout and are usually lightweight ranging from 2 to 4oz. A heavier hammer would provide a deeper point than needed. A hammer can also be used and has a magnifier that can help accurately locate intersections of scribed lines.

**PRICK PUNCHES** (see Figure 6) are used in layout because they can provide a small point to preserve the location and cause little damage to the part. The main difference between prick punches and center punches is the 30 degree included angle. After a prick punch is used to establish the location, a center punch is permitted. The center punch can be deeper so that the mark can be used to start other machining procedures.

**EXPLORE:** Starrett Automatic Center Punch



**Figure 6: Images of a Ball Peen Hammer, a Center Punch and a Prick Punch**  
(Image by Ladell Humphries, 2013)

### 1.1.2. ANGLE PLATES

**ANGLE PLATES** (see Figure 7) are used to hold work pieces at a 90 degree angle and provide support for the piece while scribing lines. They can also be used to secure the work for further machining and hold work perpendicular but also at any angle necessary to accomplish the machining task.

Angle plates are formed from a solid piece of steel. They are rough machined and precision ground. They have holes that are drilled and tapped to provide work holding options. The most basic way to hold your part against an angle plate is to use a c-clamp. These methods are most used when the piece has machining operations that have to be performed.

**EXPLORE: What Angle Plates Do**





**Figure 7: Images of an Angle Plate** (Image by Ladell Humphries, 2013)

### ACTIVITY #1

**Match the letter of the term to the appropriate definition.**

1. A pre-machining operation that will produce a template by scratching lines in raw or finished material. \_\_\_\_\_
2. Used to hold work pieces at a 90 degree angle and provide support for the piece while scribing lines. \_\_\_\_\_
3. Used in layout and are usually lightweight ranging from 2 to 4oz. \_\_\_\_\_
4. Used in layout because they can provide a small point to preserve the location and cause little damage to the part. \_\_\_\_\_



5. Provides the means to scribe radii bigger than what can be provided in a standard radius gage set. \_\_\_\_\_
6. Has one straight end and one hooked end. \_\_\_\_\_
7. Provide a backdrop on the steel that will help in seeing the lines that are being scribed. \_\_\_\_\_
8. Simulates a perfectly flat surface. \_\_\_\_\_
9. Consists of a blade, square head, center head, and protractor. \_\_\_\_\_

- A. **Angle Plate**
- B. **Ball Peen Hammer**
- C. **Dividers**
- D. **Layout Dye**
- E. **Combination Set**
- F. **Surface plate**
- G. **Engineer's scribe**
- H. **Prick Punch**
- I. **Layout**

## ACTIVITY #2

List the name of each item from the image below and describe its purpose in layout.

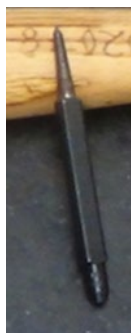
1.



2.



3.



4.



5.

## MAJOR CONCEPTS

### KEY CONCEPTS

- Semi-precision layout is used when greater accuracy is not required. The tools used in semi-precision layout are not always tools that can perform measurement but rather a tool that provides a guide to a representation of a feature.
- It is important to remember that layout is a process that helps the machinist identify locations by scribing lines on the metal. This process helps the machinist to visualize the outline of the part.
- Layout dye is used to provide a backdrop so that the lines that are scribed can be seen easily. When using layout dye it is important to apply the fluid in a well-ventilated area.

### KEY TERMS

**Angle Plate**

**Dividers**

**Scribers  
Dye**

**Layout**

**Layout**

**Prick Punch**



Ball Peen Hammer

Combination Set

Surface Plate

## ASSESSMENTS

### MODULE REINFORCEMENT

True or False: Read the following questions and determine whether the statement is true or false.

1. Semi precision layout requires a higher level of accuracy.
2. Layout dye is the chemical that provides a clean surface to scribe lines on.
3. Angle plates can be used to hold parts for further machining processes.
4. A center punch is only used after a prick punch has marked the location.
5. Dividers are used to only mark radii.
6. Layout only defines the features of a part.
7. Precision layout is performed through the use of measuring tools that discriminate .01 inches or greater.
8. A Radius Gage is an example of a semi-precision tool.
9. The center head of a Combination Set, when used with the blade can find the center of round material.
10. Cast iron surface plates are far more reliable than granite surface plates.
11. Granite surface plates are classified into three grades; AA, AB and BB.



12. Layout dyes are usually applied with a brush applicator or as an aerosol spray.
13. A Machinist Scriber has one hooked end and one straight end.
14. Spring calipers range in size from 2 to 12 inches.
15. The most common way to secure your part to an angle plate is with a c-clamp

Multiple Choice: Read the following questions or statements and select the best answer.

1. The center punch can be \_\_\_\_\_ so that the mark can be used to start other machining procedures.
  - a. more shallow
  - b. deeper
  - c. barely seen
  - d. smaller
2. The most basic way to hold your part against an angle plate is to use a \_\_\_\_\_.
  - a. C-clamp
  - b. parallel clamp
  - c. vise
  - d. 123 block
3. Layout dye is usually applied by \_\_\_\_\_.
  - a. a paint brush
  - b. a brush applicator
  - c. a toothbrush
  - d. pouring it on the steel
4. A \_\_\_\_\_ has a removable tip that can be removed and stored in the handle for safety.
  - a. pocket scriber



- b. engineer's scribe
  - c. machinist scribe
  - d. hook scribe
5. The combination set consists of a \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and protractor.
- a. blade, square head, center head
  - b. ruler, square, center finder
  - c. caliper, micrometer, ruler
  - d. divider, scribe, layout fluid
6. Layout defines location, \_\_\_\_\_, and features of a part.
- a. Small radii
  - b. Special Contours
  - c. Precise measurement
  - d. Tolerance
7. When using the combination set, the protractor mounted to the blade can be used to scribe angles within \_\_\_\_\_.
- a. 90 Degrees
  - b. 160 Degrees
  - c. 180 Degrees
  - d. 45 Degrees
8. A granite surface plate is \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ when compared to iron plates.
- a. Denser, harder and has less external stress
  - b. Impervious to water, denser and harder
  - c. Denser, more brittle, requires less care
  - d. More internal stress, denser and better temperature stabilization
9. Layout dyes should be applied \_\_\_\_\_.
- a. At a minimum of .010 of inch thick
  - b. Thick coating to allow for sharp scribe lines
  - c. Only with a brush applicator
  - d. Sparingly with an even coat.
10. Ball peen hammers are usually lightweight ranging from \_\_\_\_\_.
- a. 2 to 4 ounces
  - b. 2 to 4 pounds





- c. 4 ounces to 2 pounds
- d. 12 to 14 ounces

### Answer Key

True or False	Multiple Choice
1. F	1. B
2. F	2. A
3. T	3. B
4. T	4. A
5. F	5. A
6. F	6. B
7. F	7. C
8. T	8. B
9. T	9. D
10. F	10.A.
11. F	
12. T	
13. F	
14. T	
15. T	



## ANSWER KEYS TO ACTIVITIES

### ANSWER TO ACTIVITY #1

1. I
2. A
3. B
4. H
5. C
6. G
7. D
8. F
9. E

### ANSWER TO ACTIVITY #2

1. **Dividers** – to scribe arcs and radii
2. **Engineer's Scriber** – used for scribing lines. It has one straight and one hook end. The hook end permits easier access to the line being scribed.
3. **Pocket Scriber** – Used for scribing straight lines but has the added advantage of a removable tip that can be replaced easily.
4. **Prick Punch** – Used for marking locations in layout.
5. **Granite Surface Plate** – Used to provide a flat surface to reference the edges of a piece of steel so that the placements of layout lines are accurate.



## DISCUSSIONS

### QUESTION 1

List the steps in order of what should be done to lay out a part on steel. Explain your choice in the ordering of operations.

### QUESTION 2

The most important part of layout is having the ability to measure accurately so that the lines scribed are within tolerances and the outline that is scribed resembles the part on the blueprint. In your opinion, what would happen if someone with no training in layout attempted to create a piece that required it?



## CRITICAL THINKING

### PUTTING NEW KNOWLEDGE TO WORK

Job Description #2	Immediate Supervisor	Task	Result of Task
You are a <u>Machinist</u> ...	...your immediate supervisor, <u>Mr. Humphries</u> ,...	...has asked you to review the layout video link and list the steps taken to mark the metal...	...this will enable you to explain the steps necessary for layout procedures.

#### Student Instructions:

1. Review the video: Layout (click on link)
2. Open a word document
3. In your own words, type a list of the steps taken to layout the feature on the metal.
4. Name the word document with your last name first and first name last with an underscore between, for example: **Smith\_John**.
5. Save the word document on your personal computer.
6. Upload the document to the assigned class dropbox.



7. SMILE ...You have completed the task.



## RUBRIC SCALE

### GRADING RUBRIC FOR INSTRUCTORS

List steps from video link of layout procedure	Excellent (50 points max)	Good (45 points max)	Fair (40 points max)	Additional Practice Needed (35 points)
1. Review the video in the link.				
	Excellent (45 points max)	Good (40 points max)	Fair (36 points max)	Additional Practice Needed (32 point max)
2. Typed the list of steps taken to layout the feature on the metal.				
	Turned In On Time (5 points)	Turned in 1 day late ( 4 points)	Turned in 2 days late and gave reason to instructor on tardiness (3 points)	Turned in 3 days late or Did Not Turn In after day 2 tardiness (2 point)
3. Successfully uploaded the list of steps document to assigned class dropbox.				
<b>Total</b>				



## ATTRIBUTION TABLE

Author/s	Title	Source	License
Ladell Humphries	Figure 1: Combination Set	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 2: Screen Shot of YouTube Video “Granite Surface Table”	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 3: Example of a Layout Dye	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 4: Screen shot of YouTube Video “How to Apply Layout Fluid”	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 5: Image of a Divider and Scribes	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 6: Images of a Ball Peen Hammer, a Center Punch and a Prick Punch	Module Author	Creative Commons Attribution 3.0 Unported License
Ladell Humphries	Figure 7: Images of an Angle Plate	Module Author	Creative Commons Attribution 3.0 Unported License







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