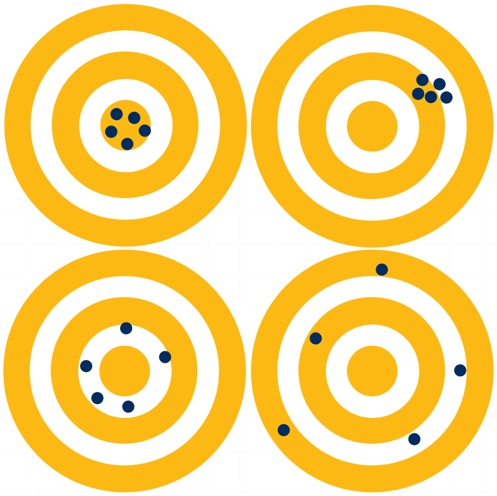
MANUFACTURE YOUR PATH

Name: ______________________

METROLOGY: The Science of Measurement

Precision and accuracy are fundamental to manufacturing, as they directly impact product quality and operational efficiency. **Precision** refers to the consistency of measurements and the ability to produce parts with minimal variation. In a manufacturing context, this means that components are created with a high degree of repeatability, ensuring that each part is nearly identical to the next. High precision in manufacturing processes, such as machining or injection molding, helps to achieve tight tolerances, which is essential for assembling products that function correctly and reliably. This consistency reduces the likelihood of defects and the need for extensive post-production adjustments, streamlining operations and saving time and resources.



Accuracy, on the other hand, relates to how close the produced parts are to the desired specifications or true values. It ensures that each component not only adheres to its intended design but also performs as expected in its final application. In sectors like aerospace, automotive, or medical device manufacturing, accuracy is critical because even minor deviations can lead to significant performance issues or safety hazards.

Manufacturing engineers understand that there are always small deviations from the intended design. It's their job to define how a part needs to be made with incredible detail to ensure that the part produced will always work. Engineers use **tolerances** on their designs to define a permissible range of variation in dimension or physical characteristics. Tolerances provide acceptable boundaries that account for minor imperfections. High accuracy ensures that parts are consistently produced near the target dimension, and tight tolerances demand precise control of the manufacturing process to ensure that any deviations remain small and within the allowable range.

Achieving both precision and accuracy helps to minimize waste, reduce costs, and enhance customer satisfaction by delivering products that meet high-quality standards and operate effectively. Together, these principles are essential for maintaining competitive advantage and ensuring the success of manufacturing enterprises.

? *Quick Start: What is the difference between precision and accuracy?*

Precision is a measure of how close measurements are to one another but accuracy tells how close the measurement is to the true value.

PART 1: PRECISION AND ACCURACY

Length and Diameter

1. Using the provided ruler, measure the 3 provided metal dowel pins in inches and centimeters. Record the length and diameter of each in the table below under Measured Value.

Table 1: Inches	Small Pin			Medium Pin			Large Pin		
	Measured Value	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*
Length	1 2.4/8			1 3.1/8			1 2.5/8		
Diameter	1.4/8			1.8/8			2.1/8		

Table 2: Cm	Small Pin			Medium Pin			Large Pin		
	Measured Value	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*
Length	3.29			3.51			3.30		
Diameter	0.49			0.59			6.6		

Quick Check: Which provided a more precise measurement, inches or centimeters? Why?

The centimeters provided a more precise measurement because all measurements were closer together. The standard deviation across the class was lower for centimeters than it was for inches.

2. Test the 3-2-1 block against the provided ruler to determine the ruler's accuracy.

Quick Check: Is the provided ruler accurate? What can help to ensure accuracy?

No, the ruler is not accurate. Calibration is necessary to ensure that the device is showing accurate results.

3. With the provided calipers, measure the 3 provided metal dowel pins in millimeters. Record the length and diameter of each in the table below under Measured Value.

Table 3: mm	Small Pin			Medium Pin			Large Pin		
	Measured Value	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*	*Measured Value*	*Class Average*	*Standard Deviation*
Length	29.98			32.00			29.99		
Diameter	3.99			4.97			5.99		

Quick Check: Why do the measured values differ from those listed on the product page?

The device itself has a defined accuracy and the products are created to tolerances that allow wiggle room. For example, the pins have a tolerance of +0"/-0.0008" or +0mm/-0.02mm. This means that the pin should never be larger than intended but could be slightly smaller than planned. Also the calipers themselves have an accuracy of ± 0.001"/ 0.02mm; Resolution: 0. 0005"/0. 01mm.

PART 2: DETERMINING FIT

Loose Running Clearance Fit- Allows for a slight gap between mating surfaces. Parts in a loose running clearance fit are free to rotate/slide and have an observable play.

Press Interference Fit- Tight fit that relies on the friction between the two surfaces to hold. Parts in a press interference fit may need to be rotated or hammered to get into place.

1. Using the provided tolerance block, record how each pin interacts with the different sized holes. Record your notes in the table below.
    a. Include observations about how much play was allowed with each pin/hole combination.
        i. Did the block spin on the pin when rotated? Freely? Every few turns?
        ii. Was it able to pass through the hole? How much force was needed?

Tolerance Block Notes	1	2	3	4	5
A	Pin used: 4mm pin Fit notes: Required push to get in, did not go all the way through, perhaps could be hammered through	Pin used: 4mm pin Fit notes: Required push to get in, did not go all the way through, perhaps could be hammered through	Pin used: 4mm pin Fit notes: Fit but could feel some friction to slide through, block can rotate if spun	Pin used: 4mm pin Fit notes: Freely slide through the hole. The pin can wiggle in the hole.	Pin used: 4mm Fit notes: Freely slide through the hole. The pin can wiggle in the hole
B	Pin used: 5mm pin Fit notes: Required push to get in, perhaps could be hammered more easily, no slippage when spun	Pin used: 5mm pin Fit notes: Required push to get in, perhaps could be hammered more easily, no slippage when spun	Pin used: 5mm pin Fit notes: Fit but could feel some friction to slide through, block can rotate if spun	Pin used: 5mm pin Fit notes: Freely slide through the hole. The pin can wiggle in the hole.	Pin used: 5mm pin Fit notes: Freely slide through the hole. The pin can wiggle in the hole.
C	Pin used: 6mm pin Fit notes: Required push to get in, perhaps could be hammered more easily, no slippage when spun	Pin used: 6mm pin Fit notes: Required push to get in, perhaps could be hammered more easily, no slippage when spun	Pin used: 6mm pin Fit notes: Fit but could feel some friction to slide through, block can rotate if spun	Pin used: 6mm pin Fit notes: Freely slide through the hole. The pin can wiggle in the hole.	Pin used: 6mm pin Fit notes: Freely slide through the hole. The pin can wiggle in the hole.

Quick Check: If you were making a toy that needed a 5mm diameter pin to tightly connect two components so they do not move and a 4mm diameter pin to allow for smooth rotation, which holes would you recommend for each?

For the 5mm pin- B1 or B2 would work best, For the 4mm pin- A4 or A5 would be ideal