HIGH SCHOOL

CONMED-LINVATEC

"Measurement & Precision"

Student Instructions/Scenario

MEDICAL MANUFACTURING

People who work in designing and manufacturing technical instruments need to understand the concept of measurement and precision. In engineering, architecture or medicine, technical instruments are required to be designed and manufactured with the highest accuracy and precision. Instruments like surgical blades are used for any type of surgery, especially orthopedic surgery, arthroscopy, endoscopy; providing means of cutting large and small bones, meniscal trimming, joint debridment, and tissue removal.

MATERIALS

Metric ruler, journal, compass, protractor, scissors, pencil, computer math program. Access to the internet – Measurement & Precision lesson plan and scenario website/handout, (caliper and/or micrometer can be used if available).

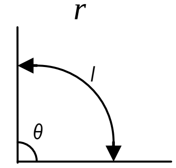
LEARNING ACTIVITIES

1. Review theory

Review and understand both metric and customary systems of measurement; understand, select, and use units of appropriate size and type to measure angles and perimeter.

Common linear measurements in the metric system include the kilometer (km), meter (m), centimeter (cm), and millimeter (mm). Naturally, each is used to measure objects at different scales. The distance between cities would best be measured in kilometers, while the distance between your toes is best measured in millimeters. You will first gain some experience with linear measurements, measuring tool, and then move on to other types of measurements.

$$\theta \approx \frac{l}{r} \times k$$



Angles: the most commonly used units to measure angles are radians and degrees. The degree is the unit widely applied in engineering and medicine. It is denoted by a small superscript circle (°).In order to measure an angle θ; a circular arc centered at the vertex of the angle is drawn. The length of the arc *(l)* is then divided by the radius of the circle r, and possibly multiplied by a scaling constant k (which depends on the units of measurement that are chosen). The measurement of angle θ (°) is 1/360 of a full circle, (one full circle is 360°).

Accuracy is about whether a measurement agrees with the true value. If a measurement is accurate then it is correct.

Precision is about whether several measurements of something agree with each other. Precision can be measured using the range of values. One half of this range is the amount by which the true value may vary above and below the average value (this is called the tolerance interval, margin of error, or a plus-or-minus amount—the ± amount). Machines used in manufacturing often set tolerance intervals, or ranges in which product measurements will be tolerated or accepted before they are considered flawed (see figure 9).

When a measurement is expressed with more digits it is generally more precise than a measurement of the same thing showing fewer digits. Each measured digit is called a *significant figure.*

Examples of measurement tools are: figures 1- Ruler, figure 2 – Flexible Measuring Tape, figure 3 – Caliper, figure 4 - Hard Measuring Tape, figure 5 – 200 feet Measuring Tape, figure 6 – Compass, and figure 7 – Protractor.

2. U Measure it

Print figure 1 – Ruler, figure 10 - Surgical Blade, and figure 13 – Reciprocating Action Blade. Measure the surgical tools in the suggested points. Use table 1 and 3 to write the measurements.

a) Use ruler provided in figure 1 and measure the following dimensions:

Surgical Blade – figure 10: total and 1/2 of the surgical blade length, the widest part of the blade, and separation between teeth. Reciprocating Action Blade – Figure 11: total length L, outside diameters D_1, D_2, and D_3. Write the results for each measurement in table 3.

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LEARNING ACTIVITIES; *Continuation*

b) Use a normal ruler or any other more precise measuring tool, (optional). Measure the same points described in (a). In addition, for the surgical blade measure angles between the teeth, angles 1, 2, and 3. See figure 10 for details. Write the results in table 1, 2, and 3 accordingly. Prepare a graphical chart to represent "accuracy" and "precision" of the data, (see figures 8 – High accuracy Low precision and figure 9 – High Precision Low Accuracy).

c) Compare results from exercise (a) and (b).

d) Accuracy and precision: Use the figure in the blackboard provided by the teacher. Each group of students should mark a dot representing the total length obtained in the exercises (a) and (b). Accuracy: See how close the individual measurements of the total length of the surgical blade agree with the correct value. Precision: check for reproducibility of measurements between groups. (Review figures 8 and 9).

e) Report at least the one dimension of the surgical blade in exercise (b) using 3 significant figures and the respective tolerance interval.

3. Zero Waste: Surgical Blade - U Design it

Use the surgical blade and reciprocating action blade from example 3 (figure 10 and 13) and a clean sheet of paper (11x8 ½").

a) What information you would need if you were designing and required to manufacture one surgical blade as shown in the picture?

b) How many surgical units of surgical blade (figure 10) can you manufacture from a sheet of paper (11x8 ½")? Draw the possible options for manufacturing the surgical blade and demonstrate the most efficient distribution design with minimum waste and maximum production units.

TABLES

Table 1- Surgical Blade Measurements for exercises 3(a), 3(b), and 3(c)

Surgical Blade-Measurements								
Group No.	Total length (centimeters)		½ of length (centimeters)		Widest part (centimeters)		Separation between teeth (millimeters)	
	ruler 1 (figure 1)	ruler 2 normal ruler	ruler 1	ruler 2	ruler 1	ruler 2	ruler 1	ruler 2
1								
2								
3								
4								
5								

Table 2 - Exercise 3(b), and 3(c)

Group No	Surgical Blade – Angle Measurements in degrees (o)			
	Angle between teeth	Angle 1	Angle 2	Angle3
1				
2				
3				
4				
5				

INSTRUCTIONS

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Table 3 - Reciprocating Action Blade Measurements for exercises 3(a), 3(b), and 3(c)

Reciprocating Action Blade Measurements								
Group No.	Total length - L (centimeters)		Diameter D_1 (centimeters)		Diameter D_2 (centimeters)		Diameter D_3 (millimeters)	
	ruler 1 (figure 1)	ruler 2 normal ruler	ruler 1	ruler 2	ruler 1	ruler 2	ruler 1	ruler 2
1								
2								
3								
4								
5								
6								
7								

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TOOLS

Figure 1 - Ruler

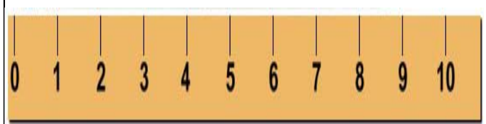

Figure 2- Flexible Measuring Tape

Figure 3 – Caliper

Figure 4 - Measuring Tape

Figure 5 – 200 feet Measuring Tape

Figure 6 – Compass

Figure 7 – Protractor

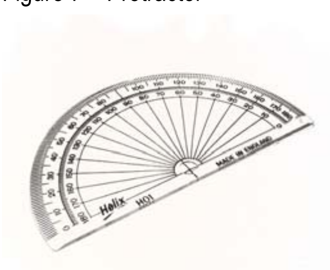

Figure 8 – High Accuracy Low Precision

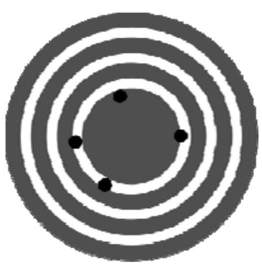

Figure 9. High Precision Low Accuracy

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Figure 10 - Surgical Blade

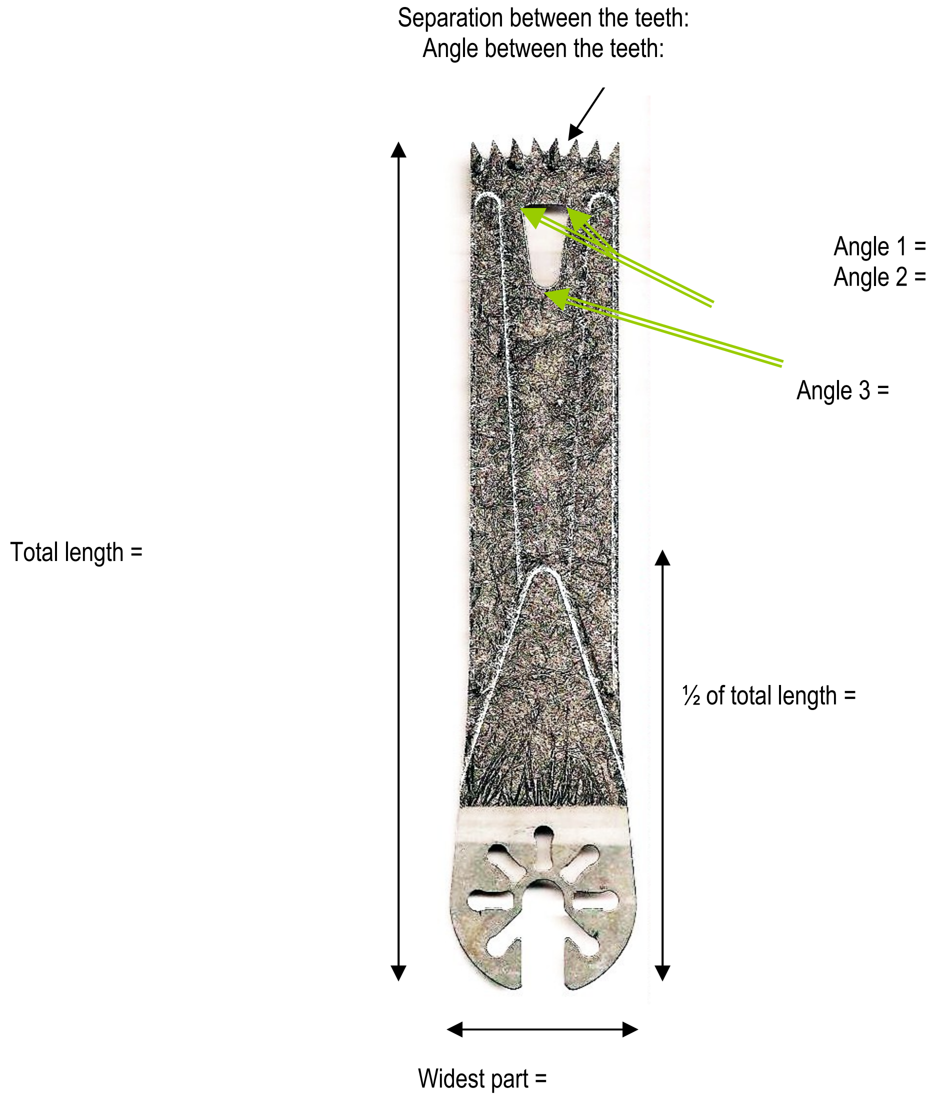

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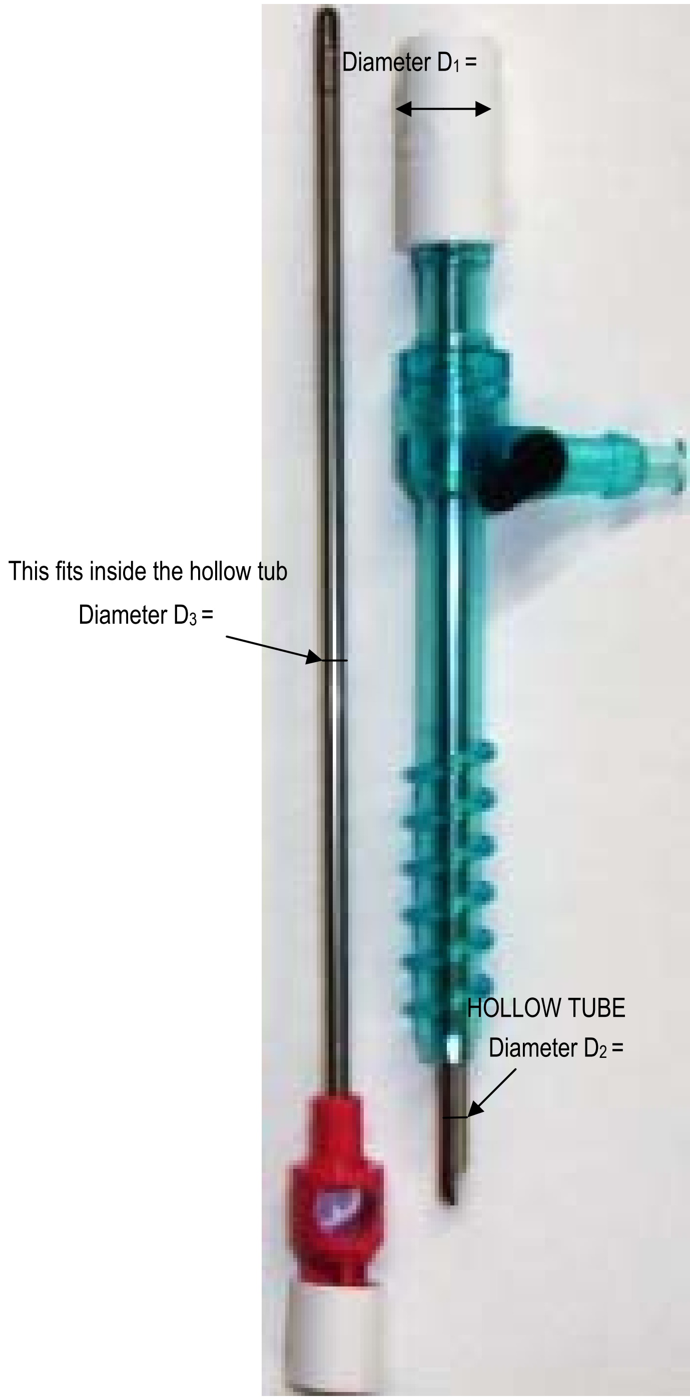
Figure 13 – Zero Waste: - Reciprocating Action Blade - U Design It.



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