High School

CONMED-LINVATEC

Measurement & Precision

Teacher Lesson Plan

Created by the Florida Advanced Technological Education Center of Excellence, FLATE
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NATURE OF LESSON:	GRADE LEVELS
Students are challenged to understand the importance of measurements and precision in the design and manufacturing of medical surgery instruments.	9-12
TARGETED SUBJECT AREA/S	**MANUFACTURING PHASE**
Science, Computer Technology, Math and Tech Ed	Test & Design
LEARNING OBJECTIVES	**TIME FRAME**
1. To understand the concept of number systems and application in problem solving and computation. 2. To understand the importance and applicability of measurements and precision. 3. To select and apply techniques and tools to accurately estimate measurements to appropriate levels of precision and accuracy required in real world situations. 4. To integrate and apply science, math, and technology.	2 class sessions (55 minutes each)

SUNSHINE STATE STANDARDS ADDRESSED

MA.912.S.1.2, MA.912.T.2.3, SC.912N.1.1, SS.912.G.1.3, SS.912.W.1.2

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

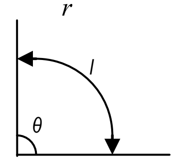
1. Review theory

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 ; a circular arc centered at the vertex of the angle is drawn. The length of the arc length (*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 (°) 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

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.* Use figures 8 and 9 to explain graphically accuracy and precision.

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Use power point presentation to compliment your lesson

a. **Exercise: How Accurate & Precise are U?**

After explaining concepts of accuracy and precision provided in power point presentation, use exercise (1a) in page 5 of presentation to graphically show students the concepts of accuracy and precision.

b. **Exercise: Tolerance Interval & Margin of Error**

Review concepts of tolerance interval and margin error with the example provided in power point presentation exercise (1b) in page 7. Add more examples if necessary.

Bell work

a) Measuring Tools & Their use (presentation page 8)

Have students brainstorm: Ask students to give examples of measurement tools and their use, then show example figures in the handout and/or in the presentation (page 8): 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, figure 7 – Protractor, (show variety of actual measuring tools if possible).

Application of different measuring tools: Tape measures can be used in tailoring or dressmaking is made from flexible cloth or plastic, or fiberglass.

Measuring tapes designed for carpentry or construction can be stiff or flexible.

Caliper is a device used to measure the distance between two symmetrically opposing sides, it is used in many fields such as metalworking, mechanical engineering, woodworking, woodturning and in medicine.

A compass can be used as a tool to measure distances for inscribing circles. It is commonly applied for mathematics, drafting, and navigation purposes.

Protractor is a circular or semicircular tool for measuring an angle or a circle. The units of measurement utilized are usually degrees.

Exercise: Measuring Tools & Units (presentation page 11)
Ask students to identify which measuring tools and units will be more appropriate to measure the length of a stadium, the classroom, desk, pencil and the diameter of an ink cartridge of a pen.

2. Part A- U Measure it

Ask students to print figure 1 – Ruler, figure 10 - Surgical Blade, and figure 11 – Reciprocating Action Blade. Ask students to measure the surgical tools in the suggested points. Use table 1and 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, as indicated in figure 11.

Write the results for each measurement in table 3.

Answer:

Surgical Blade – The best you can say about the total length of the surgical blade is about 11 centimeters. For half of the length you are certain that is 5 centimeters. You might guess and say about 5.5 centimeters, but the decimal place is just a guess.

The widest side: you are certain that it measures between 2 and 3 centimeters. You might guess and say 2.5 or 2.6 millimeters.

The separation between teeth: you can just guess 3 or 4 millimeters. Because the smallest unit on the ruler you are using is one centimeter, the precision of your measurement is to the nearest centimeter.

Reciprocating Action Blade – you are certain that the total length L is less than 19 centimeters, the outside diameter D_1 is less than 2 centimeter, D_2 and D_3 are close to half centimeter. You might estimate the measurement, but the decimal place is just a guess.

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b) Ask students to 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 shown in figure 10. Write the results in table 1, 2, and 3 accordingly.

Answer:

Surgical Blade – Total length 11.2 centimeters. Again, you might guess and say about 11.23 centimeters, but the second decimal place is just a guess. Half of the length: 5.5 centimeters. The widest side: 2.5 centimeters. The separation between teeth: 0.1 centimeter (1 millimeter). The precision of your measurement is to the nearest millimeter.

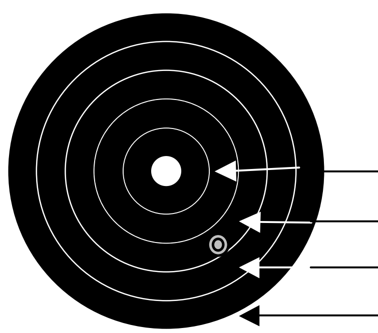
Reciprocating Action Blade – you are confident that the total length L is close to 18.4 centimeters, the outside diameter D_1 is about 1.5 centimeters. Diameter D_2 is less than 0.5 centimeters. Diameter D_3 is about 0.4 centimeters with a closer guess of 0.34 centimeters.

c) Compare results from exercise (2a) and (2b).

Answer:

The second measurement (b) is more precise, because you used a smaller unit of measurement. In mathematics, physics, engineering, and medicine it is often necessary to make measurements that are as precise as you can make them. This requires you to use measuring instruments with smaller units. Accuracy refers to how closely a measured value agrees with the correct value. Precision refers to how closely individual measurements agree with each other or degree of reproducibility.

d) Explain graphically accuracy and precision. Draw on the blackboard the figure provided and ask each group to 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 of 11.2 cm. Precision: check for reproducibility of measurements between groups. (Review figure 8 and 9).



Surgical Blade Total Length (cm)
11.0
11.1
11.2
11.3
11.4

Answer:

The total length of surgical blade is approximately 11.2 cm; the measurement obtained in exercise (3b) is more precise, because you used a smaller unit of measurement. Repeat the exercise for different measurements (optional).

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

Answer:

If a measurement made with a metric ruler is for example 5.5 cm (widest side of the blade) and the ruler has a precision of 0.1 cm, then the tolerance interval in this measurement is 5.5 ± 0.05 cm, or from 5.45 cm to 5.55 cm. Any measurements within this range are "tolerated" or perceived as correct.

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3. Part B- Zero Waste: Surgical Blade - U Design it! (Instructions for students)

Use the surgical blade and reciprocating action blade from example 3 (figure 10 and 11) 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?

Answer:

Understand the area, size and shape of saw, critical dimensions. Selection of measuring tool: depending of the required precision and shape, required significant figures, thickness of saw, type of material.

b) How many units of surgical blade (figure 10) can you manufacture from a sheet of paper (11x8 ½"). Consider minimum waste of material and maximum production of units. Students should outline or draw the possible options for manufacturing the surgical blade, total units should be numbered.

Answer: See graphical options of distribution in figures 10A and 10B

Option 1: 18 units, place blade in vertical position, perpendicular to the bottom of paper, see figure 10A.

Option 2: 19 units, place blade in horizontal position, parallel to the bottom of the paper, see figure 10B.

Once completed, share your results with the class.

EXTENSIONS & ADDITIONAL RESOURCES

These sites are useful and can be applied at any point(s) during this lesson.

1) CONMED Corporation web site: http://www.conmed.com
2) Learning Challenges: http://flate.pbwiki.com
3) Educational Pathways: http://www.madeinflorida.org/Pathways.htm
4) http://learners.gsfc.nasa.gov/challenge/discussiontopics1.html
5) Measuring instruments visit: http://www.gsource.us/catalog.php?type=47

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TABLES

Table 1- Surgical Blade Measurements for exercises 2(a), 2(b), and 2(c)

Group No	Total length (centimeters)		½ of length (centimeters)		Widest part (centimeters)		Separation between teeth (mm)	
	ruler 1 (figure 1)	ruler 2 normal ruler	ruler 1	ruler 2	ruler 1	ruler 2	ruler 1	ruler 2
1	11	11.2	5	5.5	2	2.5	3 (0.3 cm)	1 (0.1 cm)
2								
3								
4								
5								

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

Group No	Surgical Blade – Angle Measurements in degrees (^{o})			
	Angle between teeth	Angle 1	Angle 2	Angle3
1	35^0	18^0	81^0	81^0
2				
3				
4				
5				

Table 3 - Reciprocating Action Blade Measurements for exercises 2(a), 2(b), and 2(c)

Group No	Total length – L (cm)		Diameter D_1(cm)		Diameter D_2(cm)		Diameter D_3 (mm)	
	ruler 1 (figure1)	ruler 2 normal ruler	ruler 1	ruler 2	ruler 1	ruler 2	ruler 1	ruler 2
1	less than 19	18.4		1.48		0.49		3.4 mm
2								
3								
4								
5								

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Tools & Answer Key

Figure 1 - Ruler

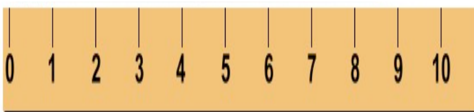

Figure 2- Flexible Measuring Tape

Figure 3 – Caliper

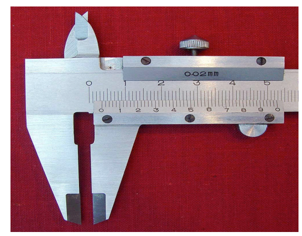

Figure 4 - Measuring Tape

Figure 5 – 200 feet Measuring Tape

Figure 6 – Compass

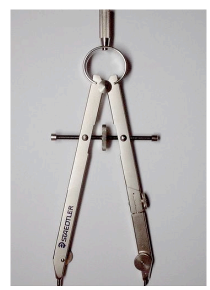

Figure 7 – Protractor

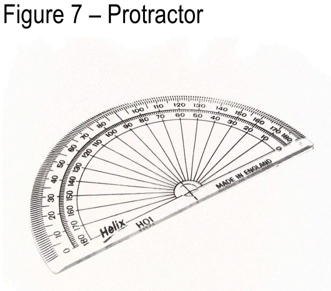

Figure 8 – High Accuracy Low Precision

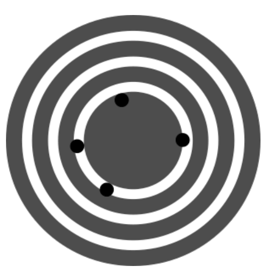

Figure 9. High Precision Low Accuracy

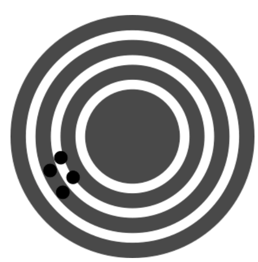

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Figure 10 - Surgical Blade

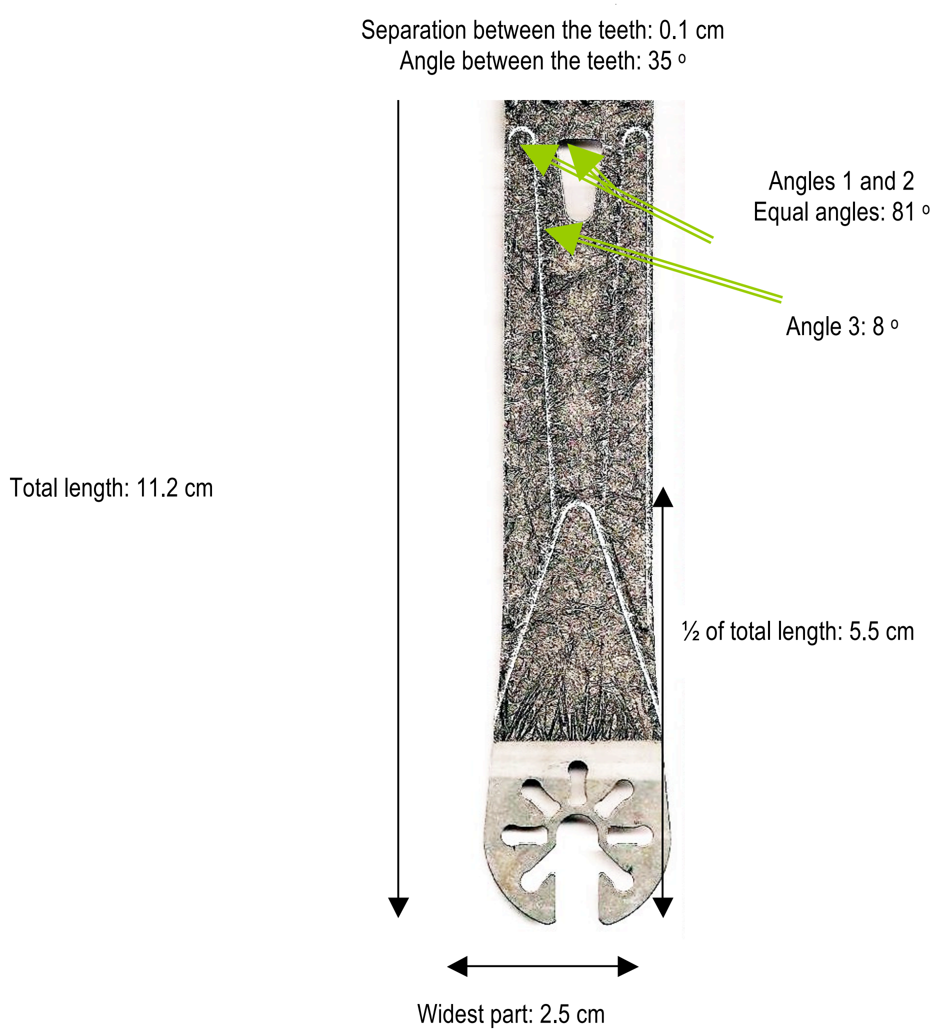

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Figure 10A – Zero Waste: Surgical Blade - U Design It. Exercise 4(b)–Answer Option 1 (Blade no to scale)

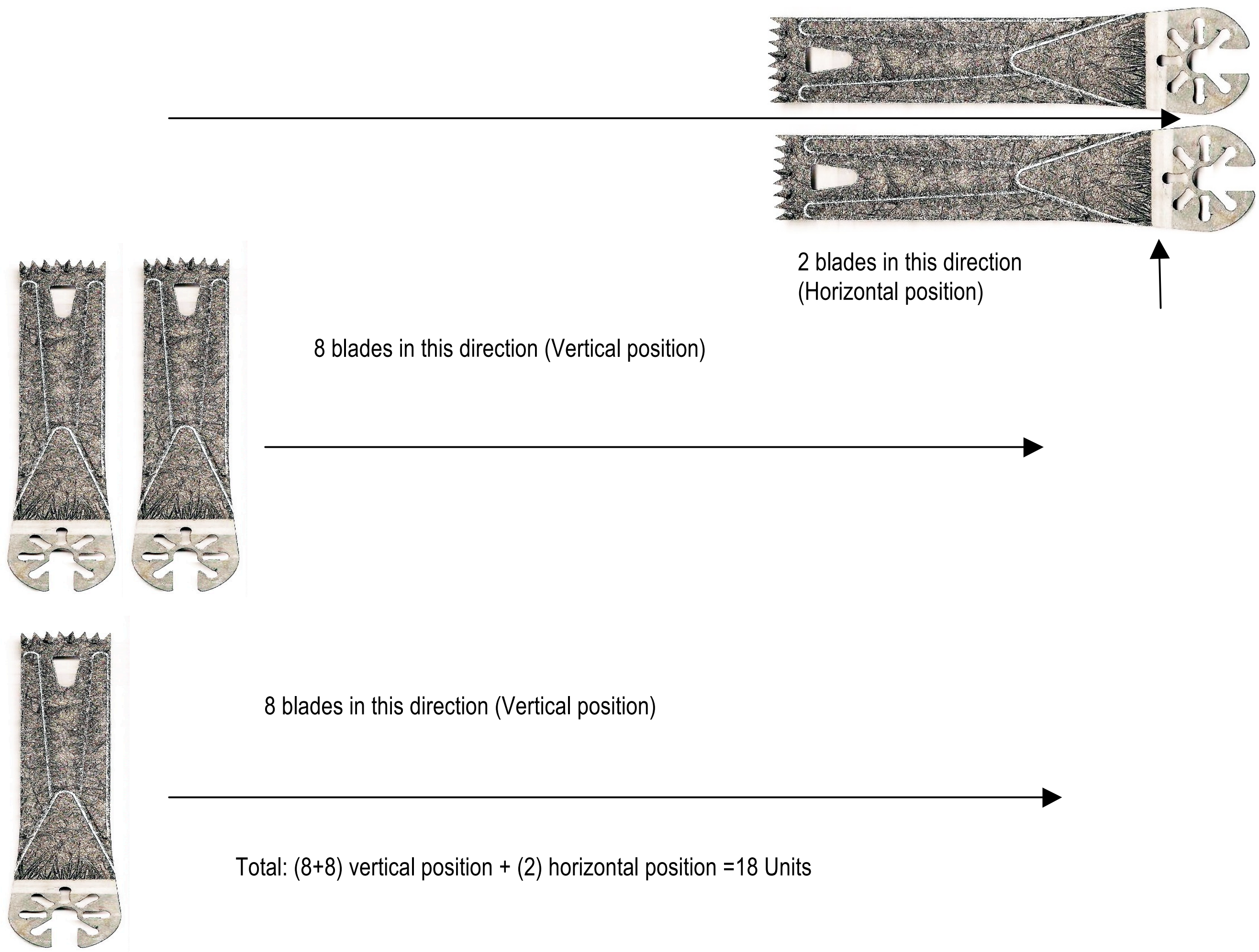

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Figure 10B – Zero Waste: Surgical Blade - U Design It. Exercise 4(b)– Answer Option 2(Blade not to scale)

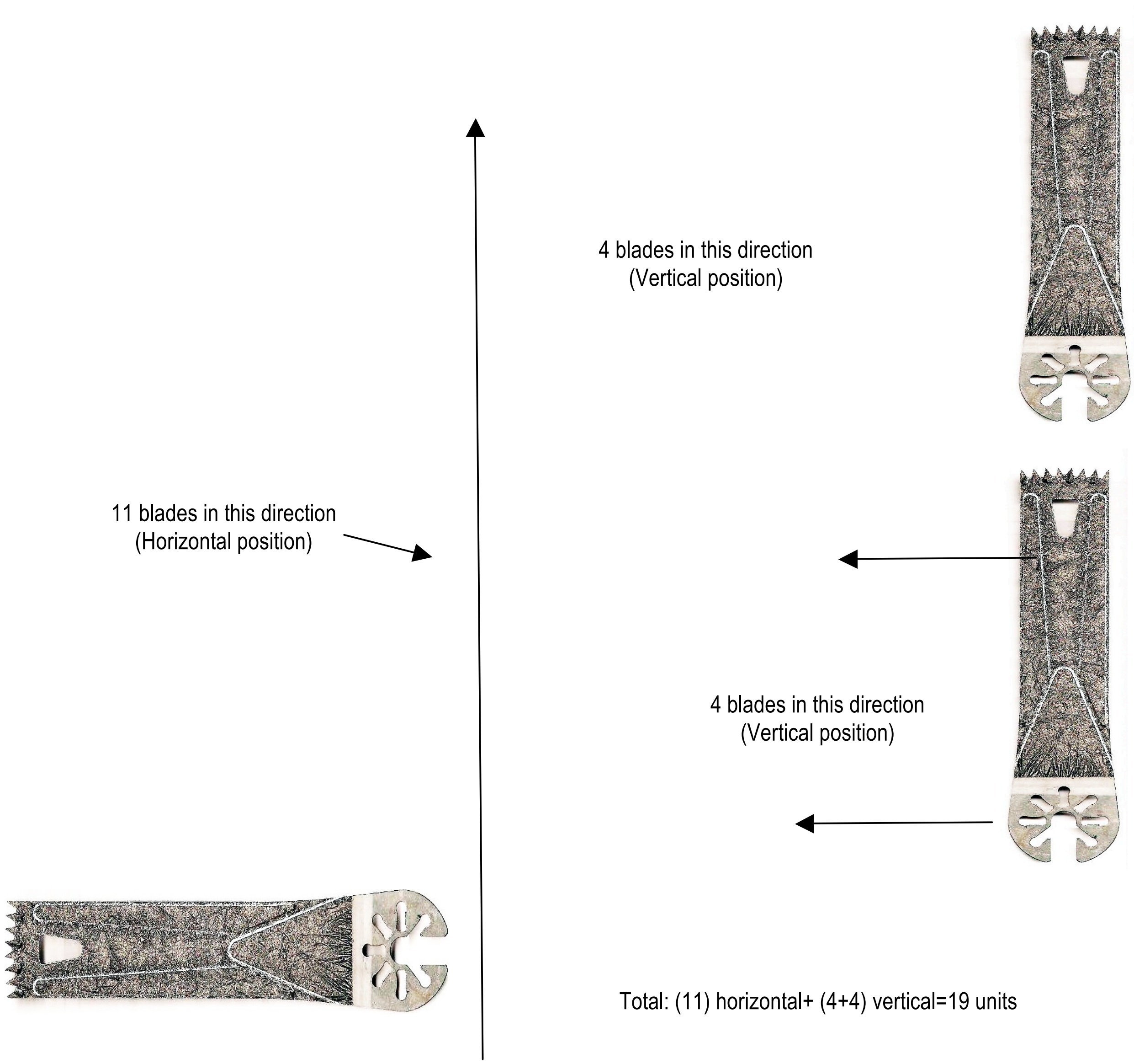

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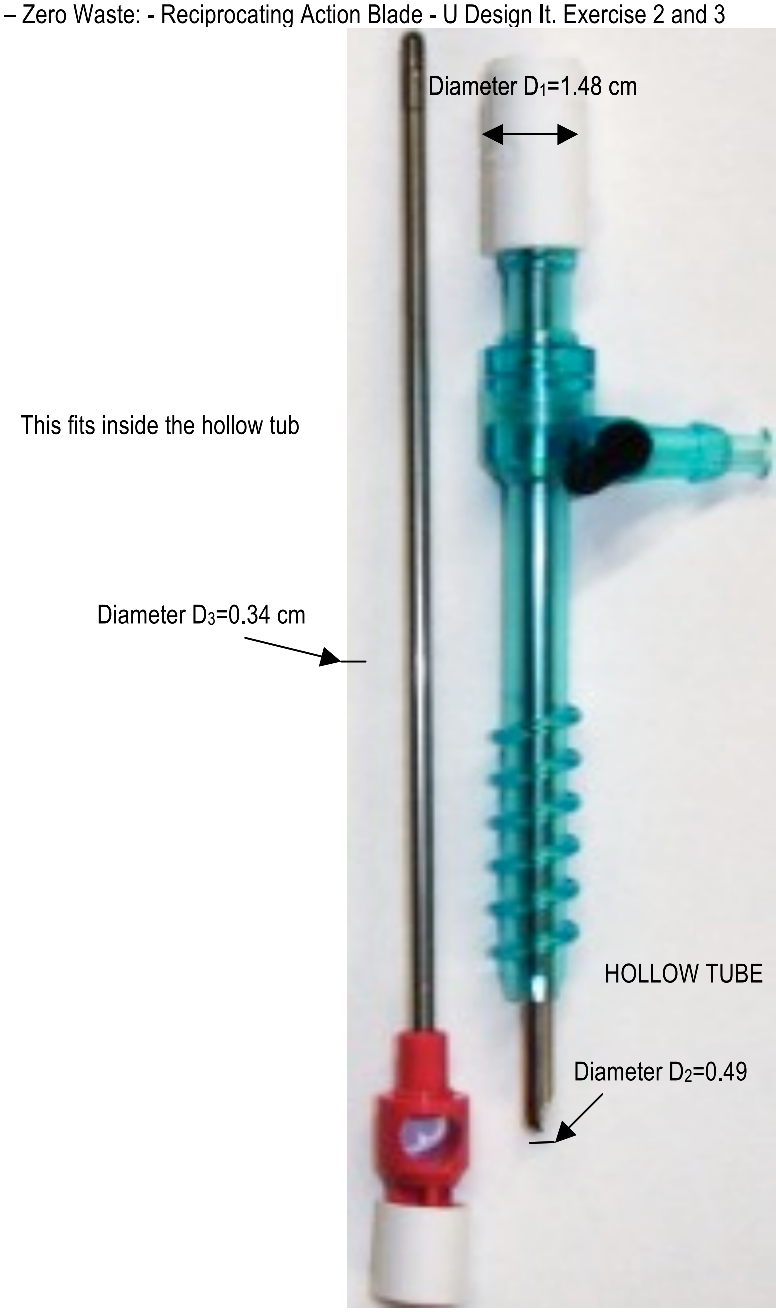
Figure 12 – Zero Waste: - Reciprocating Action Blade - U Design It. Exercise 2 and 3



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