Math-in-CTE Lesson Plan Template

Lesson Title: Calculate Drill RPM		Lesson # M03
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Occupational Area: Machine Tool Technology		
CTE Concept(s): Drill RPM + safety		
Math Concepts Formula to find Drill press RPM		
Lesson Objective:	Learn how to calculate drill RPM	
Supplies Needed:	Data charts for drill speeds, conversion charts, drill bits and other accessories. Various measuring tools such as micrometers, calipers or drill gauges. **Machining Fundamentals Textbook page 169** or Machinery Handbook	

THE "7 ELEMENTS"	TEACHER NOTES (and answer key)
1. Introduce the CTE lesson.	
Today we're going to talk about how to set RPM on a drill press for various size drills or various materials.	Safety issues: chatter, metal chips, drill feed, hole sizes
Ask: "Why do you think it would matter what speed you had your drill press RPM set to?	For safety reasons. 1 harder materials cause more resistance therefore dulling your bit, drill over heating or possibly breaking. Too much chatter can result in an oversize hole.
Ask: "How to you think different materials can affect cutting speeds?"	2 The harder the material, the slower the drill speed

Ask:" Do you think in terms of safety, that a larger drill bit should be run slower or faster than a smaller drill bit? Explain why.	The larger the drill bits, the slower the speed. REASON: The bigger the drill bit, the more chance of chatter or the drill catching and the piece could be pulled out of the vise.
2. Assess students' math awareness as it relates to the CTE lesson. Bring out some examples of different materials such as plastic, aluminum, brass, and assorted classes of steel. ASK 1. What are the differences amongst these materials? 2. How do you think the cutting speed would be affected by using these different materials? 3. Which material would generate more resistance during drilling? 4. Could cutting fluids affect cutting speed? Explain why or	*Have different materials ready for demonstration, including stock, assorted drills and cutting speed chart.* *Students may say: Not all materials are the same, there fore there should be different drilling speeds for different materials and hopefully, different speeds for different drill sizes.* *Also, listen to student discussion to see if they are familiar with vocabulary, such as drill diameter, cutting RPM, chatter, heat generation to mention a few.* ***Note**: The cutting speeds are recommended ranges for a number of reasons, such as variables in cutting techniques, depth of hole, and rigidity of the setup and overall safety pre-cautions.* ANSWERS: 1. Different materials have different characteristics, therefore they have different machinability. 2. Generally speaking, the harder the material the slower the cutting speed. 3. Harder materials would generate more resistance with the exception of some copper alloys. 4. Yes, cutting fluids will reduce heat and will carry

how? 5. What is the difference between drill RPM and cutting speed? 5b How do we determine drill speed for different materials? 6. Do you think that drill diameter has anything to do with drill RPM? 7. How would you determine the recommended drill RPM for low carbon steel using a half inch drill bit.	away cutting chips. 5. Drill speed is the actual speed the drill is turning at, while cutting speed is the recommended operating peripheral speed/range to machine the material. 5b. There is a drill chart in machinery hand book derived from the formula cutting speed times 4 all divided by drill diameter. **(CS x 4)/ drill diameter.** **CS =(Cutting Speed)** 6. The expected response is that they will answer the larger the drill bit the slower the cutting speed. 7. Upon deciding which stock material we will machine, we will determine the appropriate cutting speed range and apply it to the formula. **(CS x 4)/ drill diameter** Teacher note: remind students about order of operations when working with the formulas. (PEMDAS)
3. Work through the math example *embedded* in the CTE lesson. Let's say we had to drill a 1 inch diameter hole into a low carbon steel plate. Using the cutting speed chart, what is the recommended drill RPM?	**(CS x 4)/ drill diameter** Find the appropriate cutting speed for the carbon steel and then apply it to the formula. CS Range is 70 to 120 Let's use CS = 100 (100 x 4)/1 = 400 RPM

Let say we had to drill a 1/2 inch diameter hole into a low carbon steel plate. Using the cutting speed chart, what is the recommended drill RPM? **You will need to covert ½ into decimal form. Remember the formula? Divide the top number by the bottom. Thus 1 divided by 2 equals .5**	Find the appropriate cutting speed for the carbon steel and then apply it to the formula. CS Range is 70 to 120 Lets use CS = 100 again (100 x 4)/(.5) Answer is approximately 800 RPM *Note: Students may find the answer to be 200, mistaking the ½ of 400 rather than doing out the division which will yield the 800.*
Let say we had to drill a 1/4 inch diameter hole into a low carbon steel plate. Using the cutting speed chart, what is the recommended drill RPM?	Find the appropriate cutting speed for the carbon steel and then apply it to the formula. CS Range is 70 to 120 Lets use CS = 100 again (100 x 4)/(.25) Answer is approximately 1600 RPM

Let say we had to drill a 1/4 inch diameter hole into a titanium plate. Using the cutting speed chart, what is the recommended drill RPM?	Find the appropriate cutting speed for the titanium steel and then apply it to the formula. (Titanium is a harder material) CS Range is 15 to 20 Lets use CS = 20 (20 x 4)/(.25) Answer is approximately 320 RPM
4. Work through *related, contextual* math-in-CTE examples. 1. Let say we had to drill a .5 inch diameter hole into a thermo plastic. Using the cutting speed chart, what is the recommended drill RPM?	Find the appropriate cutting speed for the thermo plastic and then apply it to the formula. CS Range is 100 to 300 Lets use CS = 200 (200 x 4)/(.5) Answer is approximately 1600 RPM

2. Fill in the missing boxes.

Drill Bit Size	***Cutting Speed***	***Material***	***RPM***
½ inch	100	Mild steel	**?**
¼ inch	200	**?**	1600
?	20	titanium	160

Size Drill Bit	***Cutting Speed***	***Material***	***RPM***
½ inch	100	Mild steel	***800***
¼ inch	200	***Various soft materials***	1600
½ inch	20	titanium	160

(80/160)

5. Work through *traditional math* examples.

Using the cutting speed chart / feeds per revolution chart, **how long would it take to drill** a **½ inch diameter hole** 1 inch deep on a automatic feed machine with the **drill RPM at 200?**

Distance = rate x time (D = R x T) Rate = feed x Drill RPM

.006 x 200 = 1.2 (distance traveled in one minute)

1 / 1.2 = 833 1 divided by 1.2

.833 x 60=49.8 seconds to drill 1 inch deep

D = R x T = drill rpm x feed x time

Using the chart the drill is ½ inch so **R= .006**

D = 1 inch

1inch = .006inches x 200 x T

1inch = 1.2 inches per min x T

1inch/ 1.2 inches = T

.83 min = T

.83min x 60 seconds/minute = time

49.8 seconds

Provide student with the MO3 Cutting Speed Chart pdf document,

Try this math problem on the board with the class, challenge the students to try and figure it out. What is the speed of a bicycle wheel with a 24 inch diameter spinning at 200 revolutions per minute using the formula Speed = revolutions x diameter x pi (3.14)	Speed = 200 revs per min x 24 inches per rev x 3.14 Speed = 15072 inches per minute ((speed = revs x circumference)) ((speed = revs x 2 x pi x radius)) Or ((speed = revs x pi x diameter)) Convert 15072 inches per minute to MPH 15072inches/min x 60 min/hour 904320inches/hour x feet/12inches 75360feet/hour x mile/5280feet 14.27 miles per hour

6. Students demonstrate their understanding. Ask: So what advice would you give to a person drilling a hard material versus a soft material?	General answer: the harder the material, the slower the speed. The larger the drill bit, the slower the speed. There are exceptions, so consult the MO3 Cutting Speed pdf chart.
7. Formal assessment. **You have been assigned to create a part from a drawing. One of the tasks you have to perform is to drill a ¼ inch hole into pure Nickel. Using the cutting speed chart, what is the safe drilling speed range (min and max) for drilling the hole.**	Find the appropriate cutting speed for the pure nickel and then apply it to the formula. Range is 60 to 100 Lets use CS min = 60 CS max = 100 (60 x 4)/(.25) (100 x 4) / (.25) Answer is approximately 960 minimum RPM

	1600 maximum RPM