Machine Tool Technology (48.0501) T-Chart

Use proportions = Write functions or sequences that model relationships between two quantities

Program Task: Select blades for band saw operations.

Program Associated Vocabulary:
PITCH, PROPORTION, RATIO, TPI

Program Formulas and Procedures:
When selecting a blade for vertical band sawing operations, the proper blade pitch or TPI (teeth per inch) must be selected according to the thickness of the material being sawn.

TPI is a ratio like Miles Per Hour and can be written as:

$$\frac{T}{1}, \text{ which means } \frac{\text{number of teeth}}{1"}$$

Since there should be at least three teeth engaged in the material, that relationship can also be written as a ratio:

$$\frac{3}{t}, \text{ which means } \frac{3 \text{ teeth}}{\text{thickness of material}}$$

Setting those two ratios equal to each other gives the proportion:

$$\frac{T}{1} = \frac{3}{t}$$

By substituting material thickness for t and solving for T, the solution is the required blade pitch (or TPI).

Example:
What minimum blade pitch (or TPI) should be used for band sawing 3/16" thick material?

$$\frac{T}{1} = \frac{3}{3/16}$$

$$3/16\, T = 3 \times 1$$

$$16/3 \times 3/16\, T = 3 \times 16/3$$

$$T = 16$$

The required blade pitch is 16 (or 16 TPI).

PA Core Standard: CC.2.2.HS.C.3

Description: Write functions or sequences that model relationships between two quantities.

Math Associated Vocabulary:
RATIO, PROPORTION, CROSS MULTIPLY, SCALE, COEFFICIENT

Formulas and Procedures:
A proportion states that two ratios are equal.

$$\frac{a}{b} = \frac{c}{d}$$

Example:

Girls outnumber boys 5 to 3. If there were 21 boys in the class, how many girls would one expect to find?

Steps:

1. Identify the proportional relationship and label the units:

   $$5 \text{ girls to } 3 \text{ boys: } \frac{5 \text{ girls}}{3 \text{ boys}}$$

2. Set up the proportional relationship, using a variable for the missing value.

   $$\frac{5 \text{ girls}}{3 \text{ boys}} = \frac{x \text{ girls}}{21 \text{ boys}}$$

3. Cross multiply.

   $(5)(21) = 3x \rightarrow 105 = 3x$

4. Divide by the coefficient.

   $$\frac{105}{3} = x \qquad x = 35$$

   One would expect to find 35 girls.

Instructor's Script – Comparing and Contrasting
Ratios and proportions are used in every type of industry as well as in math classrooms. In working with complex problems involving ratios and proportions, it sometimes makes the problem easier to understand if you refer to an easier similar problem. An example of this is if you are dividing by a fraction remember that division is the same as multiplying by the reciprocal. This allows you to simplify complex fractions and makes the problem easier to solve.

Common Mistakes Made By Students
Students do not write each ratio consistently. For example, students may write hours/minutes = minutes/hours.

Conversions of units: In many cases, the student must convert between units before setting up the proportion. For example, if one ratio is money per hour and the student must use that ratio to set up a proportion to solve for money in a given number of days, the student must convert the number of days to hours before proceeding.

CTE Instructor's Extended Discussion
Since this particular CTE program formula always has 1 as the denominator in the first ratio of the proportion, some students may find it easier to simplify the formula to this configuration:

$$T = \frac{3}{t}$$

Then, after replacing t with the material thickness value, they are able to perform the division operation instead of using the cross multiplication method.

"t" may also be a decimal value instead of a fractional value. This is often easier for students to evaluate, because they normally are more comfortable using a calculator to solve decimal operations than fractional operations. For this reason fractions may be converted to decimals before setting up the proportion.

Frequently the solution is fractional or decimal instead of a whole number. In these cases the answer must be rounded because saw blade pitch (or TPI) is always designated by a whole number. Rounding up to the next whole number is appropriate to ensure ***at least*** three saw teeth are engaged in the material. Rounding down, even if more mathematically appropriate, would result in fewer than three saw teeth engaging the material.

Proportions are used in many machining areas including material quantity calculations, tapers and angles, scale in blueprint reading, cutting fluid mixtures, and time estimates.

Problems	Career and Technical Math Concepts	Solutions
1. When selecting a band saw blade to cut 3/8" thick aluminum, what minimum pitch should be selected?		
2. A 10" x 32" piece of 5/32" thick sheet steel needs to have a 6" diameter hole sawn in its center. What minimum TPI is required?		
3. PM Technologies received a job that requires band sawing 2500 parts and your job is to order a 300' coil of ½" wide band saw blade material. The parts will be cut from a .110" thick by 2" wide bar of stainless steel. What minimum blade pitch should you order?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. One oil change takes ¼ hr. How many changes can be done in an hour?		
5. Luke can print five posters in 15 minutes. How many can he print in one hour?		
6. Mark works 35 hours and makes $420. How much does he make if he works 25 hours at the same rate?		
Problems	**PA Core Math Look**	**Solutions**
7. Vincent buys four burgers for $ 20. What is the cost of 10 burgers?		
8. There are 27 pairs of shoes in a case. How many pairs are there in 12 cases?		
9. Margie can buy seven shirts for $94.50. What would it cost if she only bought four?		

Problems	Career and Technical Math Concepts	Solutions
1. When selecting a band saw blade to cut 3/8" thick aluminum, what minimum pitch should be selected?		$\frac{T}{1}=\frac{3}{\frac{3}{8}} \rightarrow \frac{3}{8}T=3\,x\,1 \rightarrow \frac{8}{3}\,x\,\frac{3}{8}T=3\,x\,\frac{8}{3} \rightarrow T=8$ Minimum pitch = 8
2. A 10" x 32" piece of 5/32" thick sheet steel needs to have a 6" diameter hole sawn in its center. What minimum TPI is required?		$\frac{T}{1}=\frac{3}{\frac{5}{32}} \rightarrow \frac{5}{32}T=3\,x\,1 \rightarrow \frac{32}{5}\,x\,\frac{5}{32}T=3\,x\,\frac{32}{5} \rightarrow T=19.2$ Always round up, Minimum pitch = 20
3. PM Technologies received a job that requires band sawing 2500 parts and your job is to order a 300' coil of ½" wide band saw blade material. The parts will be cut from a .110" thick by 2" wide bar of stainless steel. What minimum blade pitch should you order?		$\frac{T}{1}=\frac{3}{t}$ $\frac{T}{1}=\frac{3}{.110} \rightarrow .110T=3 \rightarrow \frac{.110T}{.110}=\frac{3}{.110}$ T = 27.27 $T=27.\overline{27}$, Always round up, 28 TPI.
Problems	**Related, Generic Math Concepts**	**Solutions**
4. One oil change takes ¼ hr. How many changes can be done in an hour?		$\frac{\frac{1}{4}\text{ hr.}}{1\text{ oil change}}=\frac{1\text{ hr.}}{x\text{ oil changes}} \rightarrow \frac{1}{4}x=1 \rightarrow (4)\frac{1}{4}x=1(4) \rightarrow x=4$
5. Luke can print five posters in 15 minutes. How many can he print in one hour?		$\frac{5\text{ posters}}{15\text{ min.}}=\frac{x\text{ posters}}{60\text{ min.}} \rightarrow 15x=5(60) \rightarrow 15x=300 \rightarrow x=20\text{ posters}$
6. Mark works 35 hours and makes $420. How much does he make if he works 25 hours at the same rate?		$\frac{35\text{ hrs.}}{\$420}=\frac{25\text{ hrs.}}{\$\,x} \rightarrow 35x=425(25) \rightarrow 35x=10{,}500 \rightarrow$ x = $300.00
Problems	**PA Core Math Look**	**Solutions**
7. Vincent buys four burgers for $ 20. What is the cost of 10 burgers?		$\frac{4}{\$20}=\frac{10}{\$x} \rightarrow 20(10)=4x \rightarrow 200=4x \rightarrow x=\$50$
8. There are 27 pairs of shoes in a case. How many pairs are there in 12 cases?		$\frac{27\text{ pairs}}{1\text{case}}=\frac{x\text{ pairs}}{12\text{ cases}} \rightarrow 1x=27(12) \rightarrow x=324\text{ pairs}$
9. Margie can buy seven shirts for $94.50. What would it cost if she only bought four?		$\frac{7\text{ shirts}}{\$94.50}=\frac{4\text{ shirts}}{\$\,x} \rightarrow 7x=94.50(4) \rightarrow 7x=378.00 \rightarrow x=\$54$