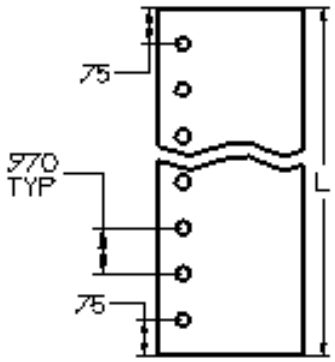
Machine Tool Technology (48.0501) T-Chart

Calculate feature spacing	=	Write functions or sequences that model relationships between two quantities

Program Task: Interpret engineering drawings.

Program Associated Vocabulary:
TYPICAL SPACING, LINEAR EQUATION

Program Formulas and Procedures:
An engineering drawing may specify several similar parts with only one image to save space and time as shown in the sketch below. Parts can be produced with any desired number of holes. The typical hole spacing means the spacing is the same for all holes. The length of the part will depend on the number of holes required.



Example 1:
Calculate the overall length of the part if 7 holes are required.

L = Overall length of the part
N = Number of holes
S = (Bottom Space + Top Space)
TYP = Typical Hole Spacing

Equation

$L = (TYP)(N) + S$

$L = (.970)(7) + 1.5$

$L = 6.790 + 1.5$

$L = 8.290$

Example 2:
Calculate the overall length of the part if 12 holes are required.

$L = (TYP)(N) + S$

$L = (.970)(12) + 1.5$

$L = 11.64 + 1.5$

$L = 13.14$

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

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

Math Associated Vocabulary:
LINEAR EQUATION, SLOPE, SLOPE-INTERCEPT FORM, POINT-SLOPE FORM, STANDARD FORM, X-INTERCEPT, Y-INTERCEPT

Formulas and Procedures:
$Y = mx + b$ Slope-intercept form of a linear equation

$Ax + By = C$ Standard form of a linear equation

$(y - y_1) = m(x - x_1)$ Point-Slope form of a linear equation

$m = \frac{(y_2 - y_1)}{(x_2 - x_1)}$ Slope formula

Example:
If you rent a DVD from Video Store A, you pay $2.95 for each DVD and an initial fee of $10 to join. If you rent them from Video Store B, you pay $3.95 for each DVD but there is no initial fee.

a.) Set up a linear equation representing the amount you will pay for DVD's at each store.

Store A $y = 2.95x + 10$

Store B $y = 3.95x$

b.) Identify the values that represent the slope and y-intercept for each of these equations.

Store A slope = 2.95 y-intercept = 10

Store B slope = 3.95 y-intercept = 0

c.) Determine the cost of renting 3, 5, and 10 DVDs from each store.

STORE A	STORE B
y = 2.95x + 10	y = 3.95x
y = 2.95(3) + 10	y = 3.95(3)
y = $18.85	y = $11.85
y = 2.95(5) + 10	y = 3.95(5)
y = $24.75	y = $19.75
y = 2.95(10) + 10	y = 3.95(10)
y = $39.50	y = $39.50

Instructor's Script – Comparing and Contrasting
Looking at the linear equations in the machine tool industry, you can see the application in action. They may not use the exact same terminology as the math instructor, but the concepts are the same.

Common Mistakes Made By Students
In algebra, students learn about many different forms of a linear equation. A mistake that students sometimes make is to feel overwhelmed and not know where to start. It is important to start somewhere and go from there. Analyze the given information and see what else you can learn from what is given.

Slope-intercept form (y = mx + b): When using the slope-intercept form of the equations of a line, students sometimes forget how to interpret the equation. The equation y = mx + b is used with m representing the slope of the line and b representing the y-intercept of the line. Also, students sometimes make order of operations mistakes if they are putting the equation from one form to another form.

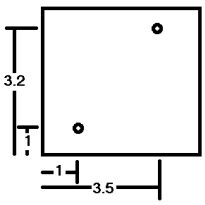
Point-slope form ($(y - y_1) = m(x - x_1)$): When using the point-slope form of the equations of a line, students sometimes forget how to distribute or make mistakes with the signs of numbers. It is important to remember that a negative multiplied by a negative is a positive number.

Standard form (Ax + By = C): When using standard form of a linear equation students often make the mistake of not following directions about how the answer should be given. Typically answers in standard form are to be integers with **A** being a positive integer. If you have fractions or decimals you can multiply by the common denominator or by a multiple of 10 to change your answer to the form of the answer that may match the multiple choice answer.

Slope: When using the slope students often mix up the x and y values of the points they are working with and the order in which they are to be entered into the formula. The formula is written in a way that should help students with this. For instance y_2 means "the y value of the second point".

CTE Instructor's Extended Discussion
Linear equations can be used in many different areas in the machining field. Students often perform math computations but don't realize they are actually creating an equation to solve a problem. If they can be guided to formulate their math calculations into an equation, the equation can be saved for future use or modified to be used in new situations. Other situations that can use linear equations include calculating linear placement of holes, material usage, machining time, costs, or wages.

Example: Two holes are already drilled in a plate. A third hole must be drilled at x = 3. Where will the hole be placed vertical so that it is co-linear with the other holes?



$(1,1)(3.5,3.2)$

$$m = \frac{3.2 - 1}{3.5 - 1} = \frac{2.2}{2.5} = 0.88$$

y = mx + b plug in a point and the m

1 = 0.88(1) + b

1 - 0.88 = 0.88 + b - 0.88

0.12 = b

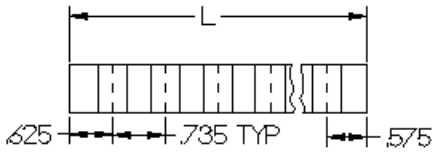
The equation is y = 0.88x + 0.12.

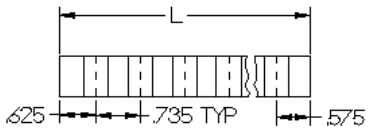
Substitute x = 3 to find the y value.

y = 0.88(3) + 0.12

y = 2.76

The third point should be placed at (3, 2.76).

Problems	Career and Technical Math Concepts	Solutions
1. What is the overall length of the part if 6 slots are to be machined?  		
2. An aerospace component you produce requires 3.2 hours of turning operations and .45 hours of milling operations. You also charge 2 hours setup time for each run. How many hours of shop time will you charge the customer for an order of 15 components?		
3. Two holes are already drilled in a plate at (1.2, 1) and (2.4, 3). A third hole must be drilled at x = 5. Where will the hole be placed vertical so that it is co-linear with the other holes?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. Find the x and y intercepts of the equation $3x + 5y = 45$.		
5. Put the equation $5x + 10y = 70$ in slope-intercept form.		
6. Given the point (5, -10) and a slope of -2. Write the equation in point slope form then change it to slope intercept form.		
Problems	**PA Core Math Look**	**Solutions**
7. You would like to buy new jeans and t-shirts to back to school. Jeans cost $40 and t-shirts $15. You have a $260 budget. Set up a linear equation to represent the amount you could spend on jeans and t-shirts and stay within your budget.		
8. Using problem # 7 set up a chart to show purchasing 1 through 6 pairs of jeans. Explain the results of this table.		
9. Your student club has decided to sell Spirit T-shirts and gets a profit of $7 per shirt. If your club account currently has $300, how many t-shirts would the club have to sell in order to raise a total of $500?		

Problems	Career and Technical Math Concepts	Solutions
1. What is the overall length of the part if 6 slots are to be machined? 		L= (TYP)(N) + S L = (.735)(6) +1.2 L = 4.410 +1.2 L = 5.610
2. An aerospace component you produce requires 3.2 hours of turning operations and .45 hours of milling operations. You also charge 2 hours setup time for each run. How many hours of shop time will you charge the customer for an order of 15 components?		T = Total Time N = Number of Parts <u>Note factoring out the "N"</u> T = 3.2N + .45N + 2 T = N(3.2 + .45) + 2 T = N(3.65) + 2 T = 15(3.65) + 2 T = 56.75 Hours
3. Two holes are already drilled in a plate at (1.2, 1) and (2.4, 3). A third hole must be drilled at x = 5. Where will the hole be placed vertical so that it is co-linear with the other holes?		$(1.2,1)(2.4,3) \rightarrow m = \frac{3-1}{2.4-1.2} = \frac{2}{1.2} = 1.67$ y = mx + b plug in a point and the m 1.2=1.67(1) + b → –0.47 = b The equation is y = 1.67x - 0.47. Substitute x = 5 to find the y value y=1.67(5) + -0.47 → y = 7.88 The third point should be placed at (5, 7.88).
Problems	**Related, Generic Math Concepts**	**Solutions**
4. Find the x and y intercepts of the equation 3x + 5y = 45.		To find the x-intercept, set y equal to zero and solve. 3x + 5(0) = 45 (Substitute) 3x = 45 (Simplify) x = 15 (Divide by 3) To find the y-intercept, set x value equal to zero and solve. 3(0) + 5y = 45 (Substitute) 5y = 45 (Simplify) y = 9 (Divide by 5)
5. Put the equation 5x + 10y = 70 in slope-intercept form.		Solve the equation for y. 5x + 10y = 70 (Write equation.) 10y = -5x + 70 (Subtract 5x from each side.) y = -½ x + 7 (Divide each term by 10).
6. Given the point (5,-10) and a slope of -2. Write the equation in point slope form then change it to slope intercept form.		$(y - y_1) = m(x - x_1)$ (Write formula.) (y – (-10)) = -2(x – 5) (Substitute.) (y + 10) = -2x + 10 (Simplify and distribute.) y = -2x (Subtract 10 from each side.) The slope is -2 and the y-intercept is 0.
Problems	**PA Core Math Look**	**Solutions**
7. You would like to buy new jeans and t-shirts to back to school. Jeans cost $40 and t-shirts $15. You have a $260 budget. Set up a linear equation to represent the amount you could spend on jeans and t-shirts and stay within your budget.		Let x = jeans and y = t-shirts 40x + 15y = 260
8. **Solution** Answers may vary. The chart shows the number of jeans and t-shirts you can buy and how much money you may have left after purchasing the clothes. If you wanted to spend your entire budget you would need to buy 2 pair of jeans and 12 t-shirts or 5 pair of jeans and 4 t-shirts.		<table><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>y</td><td>14</td><td>12</td><td>9</td><td>6</td><td>4</td><td>1</td></tr><tr><td>$ left</td><td>10</td><td>0</td><td>5</td><td>10</td><td>0</td><td>5</td></tr></table>
9. Your student club has decided to sell Spirit T-shirts and gets a profit of $7 per shirt. If your club account currently has $300, how many t-shirts would the club have to sell in order to raise a total of $500?		y = 7x + 300 500 = 7x + 300 (Subtract 300 off each side) 200 = 7x (Divide both sides by 7) 28.6 = x You would have to sell 29 T - shirts.