Manufacturing Computers
Grades: 9-12
Topics: Algebra, Manufacturing Efficiency

Big Idea(s):

- Mathematics can be used to improve the efficiency of the manufacturing process.

Concepts:

1. Mathematical calculations can be used to eliminate downtime on an assembly line leading to increased efficiency.
2. The efficiency of assembly lines can be increased in a variety of ways.
3. Eliminating inefficiencies on an assembly line leads to higher productivity and increased profits.

Objectives: (With Blooms Level)

1. Students will create a worker schedule that maximizes assembly line output in a simulated situation. (Synthesis)
2. Students will critique their classmates' scheduling decisions through the use of mathematics. (evaluation)

Vocabulary: Assembly line, Efficiency, Mass Production, Specialization

Essential Questions:

1. Given an equal number of workers per task, what factor will determine the maximum output of a product in an assembly line situation?
2. Describe how manpower must be allocated in order to maximize efficiency in an assembly line situation.
3. What are some different ways that the efficiency of an assembly line can be improved?

Lesson:

1. Watch the video *Manufacturing Computers*
2. Complete the *Marzano Vocabulary Sheet* for the term *assembly line*.
3. Ask why the invention of the assembly line and mass production was an important achievement in human history. (It allowed for ordinary people to have access to items that were once only be available to the very rich.)
4. Ask how an assembly line speeds up the manufacturing process. (It saves time because workers don't have to constantly change tasks. People become more efficient when they are able to become a specialist at completing a particular task. It allows for easier quality control.)
5. Ask why companies are always trying to improve the speed at which they produce a product while minimizing the number of workers they use. (So they can make more money.)
6. Hand out the *Time of Production per Task* sheet.
7. Explain that by properly scheduling employees, manufacturers can reduce their employee costs while increasing production. Tell the class that they are going to do a simulation where they are the managers of a computer factory and they are going to try and maximize profit.
8. Have the students take a moment to examine the chart. Ask the students, "If an assembly line is supposed to improve efficiency, why was one person more efficient than ten in this simulation?"
9. If students are unable to determine the breakdown give the following hint: If each person in the simulation was assigned to only one task. What is the power supply maker doing after the two minutes it takes him to complete his task? (Waiting for the Micro Processor worker, Memory Board worker to finish their component, Etc.)
10. Ask the students, "What needs to happen so that the people making components that don't take as long to build are productive while the tasks that take longer are completed?" (They need to find something to do. More people need to be hired to do the tasks that take longer.)
11. Ask the students why the times to produce components are longer for an individual than for multiple individuals doing different tasks. (Specialized individuals become expert on their task.)
12. Ask the students if they were to hire a second person to build micro processors how they could determine the new time necessary for one micro processor to be produced. (7 minutes ÷ 2 people = 3.5). How long would it take to make a computer now? (4 minutes. This is now the maximum amount of time needed to complete a single component). How has this increased efficiency? (By adding one worker your were able to produce nearly double the number of computers)
13. Discuss how students could further improve efficiency. (Add additional workers to long tasks.)
14. Have the students move to the computers and log into the simulation.
15. Model how to place inputs into the simulation to come up with a CPH figure.
16. Have the students work in groups of three to try and maximize their CPH efficiency. Have them place their final schedule into the blank column of the *Time of Production per Task* sheet. (an example is on the bottom half of the sheet for them to reference)
17. Circulate and make sure that students are also completing the section of the sheet that asks them to explain what they did mathematically to ensure the most efficient scheduling.
18. Have each group present their factory schedule to the class along with their reasons for determining the schedule. Have other groups critique whether or not they could have created a more efficient schedule

Schedule workers for each task in order to maximize the number of computers made per person each hour. (CPH)

Name(s): _____
_____
_____

Trial 1:

Time of Production Per Task	Time needed to produce components, 1 person	Time needed to produce components, 1 person per task	Workers used	Minutes to produce 1 component
Micro Processor[1]	13 minutes	7 minutes		
Memory Board[2]	9 minutes	4 minutes		
Drive Controllers[3]	8 minutes	4 minutes		
Motherboard[4]	6 minutes	2.5 minutes		
Power Supply[5]	5 minutes	2 minutes		
Hard Drive[6]	4 minutes	1.25 minutes		
CD ROM Drive[7]	3 minutes	1 minutes		
Floppy Drive[8]	2 minute	.5 minutes		
Monitor[9]	2 minute	.5 minutes		
Package[10]	3 minutes	1.25 minutes		
Total Time to Produce 1 Computer	55 minutes	7 minutes		
People used to Produce 1 Computer	1	10		
CPH (Computers per person per Hour) = 60min ÷ min ÷ #people	60 ÷ 55 ÷ 1 = 1.09	60 ÷ 7 ÷ 10 = .857		

Explain how you reached your CPH number:

_____

_____

_____

_____

_____

_____

(Example)

Time of Production Per Task	Time needed to produce components, 1 person	Time needed to produce components, 1 person per task	Workers used	Minutes to produce 1 component
Micro Processor[1]	13 minutes	7 minutes	4	7÷4= 1.75
Memory Board[2]	9 minutes	4 minutes	2	4÷2 = 2
Drive Controllers[3]	8 minutes	4 minutes	2	4÷2 = 2
Motherboard[4]	6 minutes	2.5 minutes	3	3÷2.5 = 1.2
Power Supply[5]	5 minutes	2 minutes	4	4÷2 = 2
Hard Drive[6]	4 minutes	1.25 minutes	2	2÷1.25 = 1.6
CD ROM Drive[7]	3 minutes	1 minutes	1	1÷1 = 1
Floppy Drive[8]	2 minute	.5 minutes	1	1÷.5 = 2
Monitor[9]	2 minute	.5 minutes	1	1 ÷ .5 = 2
Package[10]	3 minutes	1.25 minutes	2	2÷1.25 = 1.6
Total Time to Produce 1 Computer	55 minutes	7 minutes	2 minutes	
People used to Produce 1 Computer	1	10	22	
CPH (Computers per person per Hour) = 60min ÷ min ÷ #people	60 ÷ 55 ÷ 1 = 1.09	60 ÷ 7 ÷ 10 = .857	30 ÷ 22 = **1.36**	

Explain how you reached your CPH number:

The number of employees hired reduced the longest time needed to make a component down to 2 minutes. Since there are 60 minutes in an hour this means 30 computers can be made in an hour (60 ÷ 2). In order to achieve this number we required 22 total employees. In the case of the Micro Processor, had we hired only 3 people instead of four, this would have resulted in 2.33 minutes needed to make a component which would have decreased our efficiency.

Note: This answer is *not* the best answer!!! You still have wait times of up to 1 minute between components.

Answer Key: Most Efficient Schedule

Time of Production Per Task	Time needed to produce components, 1 person	Time needed to produce components, 1 person per task	Workers used	Minutes to produce 1 component
Micro Processor[1]	13 minutes	7 minutes	28	7÷28 = .25
Memory Board[2]	9 minutes	4 minutes	16	4÷16 = .25
Drive Controllers[3]	8 minutes	4 minutes	16	4÷16 = .25
Motherboard[4]	6 minutes	2.5 minutes	10	2.5÷10 = .25
Power Supply[5]	5 minutes	2 minutes	8	2÷8 = .25
Hard Drive[6]	4 minutes	1.25 minutes	5	1.25÷5 =.25
CD ROM Drive[7]	3 minutes	1 minutes	4	1÷4 = .25
Floppy Drive[8]	2 minute	.5 minutes	2	.5 ÷ 2 =.25
Monitor[9]	2 minute	.5 minutes	2	.5 ÷ 2 =.25
Package[10]	3 minutes	1.25 minutes	5	1.25÷5 =.25
Total Time to Produce 1 Computer	55 minutes	7 minutes	.15 minutes	
People used to Produce 1 Computer	1	10	96	
CPH (Computers per person per Hour) = 60min ÷ min ÷ #people	60 ÷ 55 ÷ 1 = 1.09	60 ÷ 7 ÷ 10 = .857	60 ÷ .25 = **2.50**	

Explain how you reached your CPH number:

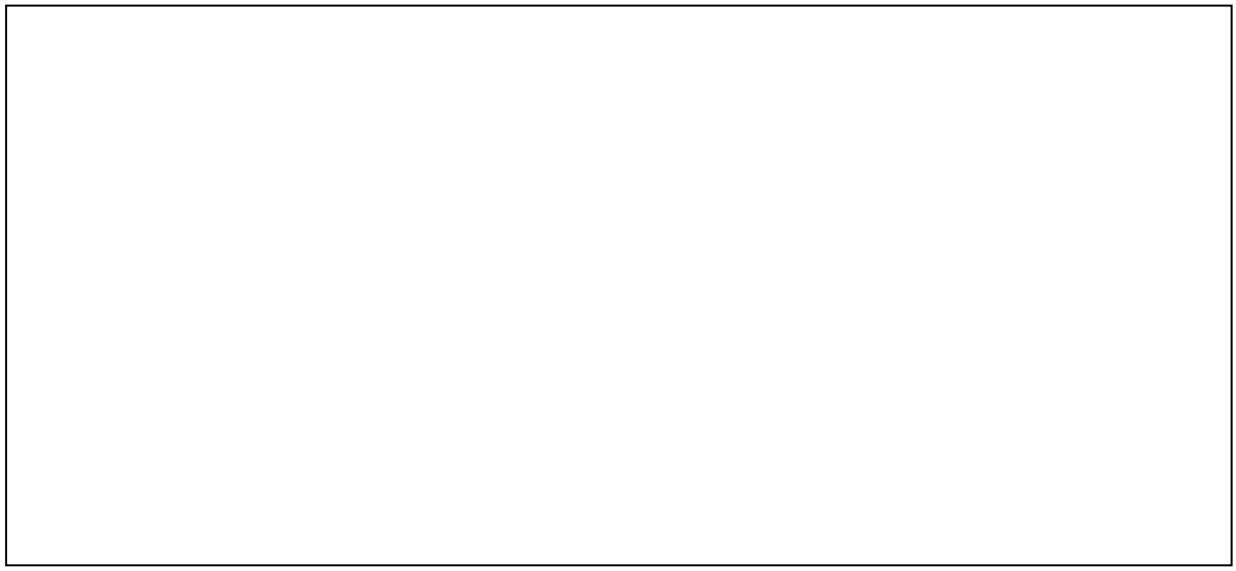
The number of employees hired reduced the time needed to make each component down to 15 seconds. In order to eliminate the need for people to wait for another component to be finished, we figured out that if you multiplied each minute needed to complete an item by 4 and hiring this number of workers to do the task, you would end up reducing the time to produce all items to an identical 15 seconds. Multiplying by 2 would have come close, but for the hard drive and packaging components that take 1.25 minutes to complete, you would have needed 2.5 people (3 since you cannot have half a person) which would have reduced the efficiency of the operation.

Marzano Vocabulary Sheet: **Name: _____**

Assembly Line

Write a definition in your own words:

Draw a picture of the word:



Use the word in a sentence:

Rate how well you understand the word:

1	2	3	4	5
Not at all	a little	okay	pretty well	I can teach somebody else