1) INTRODUCTION:

American Abrasives, Inc. is a manufacturer of coated abrasives such as sandpaper and other abrasives products like grinding wheels. The firm's main market is the industrial companies which use abrasives for a variety of their finishing operations.

The company's Elyria plant fails to meet shipping order requirements. The primary reasons regarding to fail are scheduling problems, machine downtime, and insufficient throughput rates. It is clear that a major contributing problem is the frequent bottlenecks created by the Maker machine's long setup and processing times. Another concern is the frequent breakdowns of Treater machine which is not yet a problem but may create bottlenecks and decrease the impact of new Maker machine.

One of the alternatives for handling this problem is the purchase of a new Maker machine; however, there are some constraints regarding to capital, so we need to figure out the setup and processing rates.

2) MANUFACTURING PROCESS:

The manufacturing of abrasives consists of production of a flexible backing, an adhesive film, and a coating of abrasive grains. Each involving different combination of materials for production.

The first phase of production involves the placement of the backing on the Spindle; thereby facilitating the handling of the backing throughout the process. Next, the backing is sent to the Washer, which prepares the backing for the final treatment by removing impurities from its surface. The backing then goes through the Treater, here various chemicals are applied to it to maximize bonding with the abrasive. At the end of this step the material is placed in a WIP inventory, before it is sent for further processing.

From the WIP the material is transferred to the Maker. At the maker the material passes through various processes, e.g. printer, adhesive Treater, and electrostatic process. The backing goes through drying chamber and sizing coating. After which the product is stored in large rolls and stored. Any new machine would integrate these last two steps with the Maker machine, thereby amounting to considerable space savings.

Next, the rolls are cut in regular batches of ten tons each by the Flexor process. The final step consists of finishing, where the rolls are cut into sheets or disks, or belts. At the end of this, the goods are packaged and shipped.

The Elyria plant also produces goods from semi-finished material; they are transported to the Maker machine directly for processing.

All of the products manufactured at Elyria can be divided into three broad categories, as follows:

Class	Annual Demand (units)	Production Quantity	Production from
A	800	10	Raw Material
B	1,600	20	Semi-finished
C	2,670	30	Raw Material

As far as the delivery of raw materials and semi-finished is concerned there is no problem. Thus prompting the management to focus on the manufacturing process. The plant is run at capacity with three shift a day, machines are idle only during scheduled maintenance and holidays. The factory operates for approximately 8,000 hours per year.

3) ALTERNATIVES:

- Status Quo: In that alternative, we have to keep our old Maker machine and this will cause us not to meet the customer requirements. In this model, we are unable to deliver a total of 3930, 7860, and 14449 from products A, B, and C respectively.

- Purchasing a new Maker machine which has 5 different models with processing times of 1.0, 1.5, 2.0, 2.5, and 3.0 hours per unit, and which has a setup time of 1.0 minute regardless of the machine size. Each half hour reduction in the processing time (below 3.0) costs us $4.4 million. Since the reduction in the number of workers is regardless of the machine size -from 40 in the old model to 21 in the new model which is built with the new Maker machine-, we do not consider it as a cost saver in different models of the new Maker machine. However, when compared with the old model, it saves us (40-21)*($23.60/hour)=$448.4/hour.

4) THE ANALYTICAL ANALYSIS:

Since we have 5 different models of the new Maker machine, we need to figure out which machine is the most appropriate one for our needs -to meet customer orders-. We ran our second model with the new Maker machine for different processing times. The results regarding to one run (annually) are as follows (the second numbers are shortages encountered):

Time	Setup times	Product A	Product B	Product C
3.0	1.0	440/360	880/720	1302/1364
2.5	1.0	520/280	1057/550	1560/1100
2.0	1.0	650/150	1301/299	1950/723
1.5	1.0	810/0	1620/0	2670/30 ***
1.0	1.0	810/0	1620/0	2679/20

Our current annual demand is 800 units for A, 1,600 units for B, and 2,670 units for C. Since the fourth Maker machine is fulfilling our customers' needs, we do not have to spend $4.4 million for a quicker machine which has a processing time of 1.0 minute. Thus, the processing rate which is required from the new Maker machine is 1/processing time, which is 0.66/minute.

5) THE MODELS:

Both models that we built under XCELL+ are virtually the same. The mere difference is that in the second model with the new Maker machine, our setup time became 1.0 from 5.5, and the processing time regarding to Maker machine became 1.5 from 3.0.

Model 1: Timeunit=1 hour. Process A: Product A. Process B: Product B.
Process C: Product C. Standard production quantities are 10, 20, and 30 for A, B, and C respectively.

Receiving Areas: Arrivals and storage capacity are unlimited.

Shipping Areas: Regular batch size of 10 for all products. Storage capacity is sufficient for 2 production batches for each product.

Time between shipments:

--A: (8,000 hours/year)/(80 batches/year)=100 hours.

--B: (8,000 hours/year)/(160 batches/year)=50 hours.

--C: (8,000 hours/year)/(267 batches/year)=30 hours.

Buffers: We have two buffers. One is the Work-In-Process inventory with a capacity of 1 unit between Treater and Maker. The other has a capacity of 20 units between Maker and Flexor machines. Both buffers have FIFO.

Workstations:	Setup times	Processing times
Spindler	1.0	1.0
Washer	0.5	1.0
Treater	0.5	1.5
Maker	5.5	3.0
Flexor	2.0	1.0

As pointed out above, for the second model, the Maker machine's setup time is 1.0, and its processing time is 1.5. We also have a Dummy workstation with processing and setup times of zero.

--Spindler: Has X-input from raw materials receiving area and has normal output to Washer.

--Washer: Has X-input from Spindler and normal output to Treater.

--Treater: Has X-input from Washer and normal output to WIP buffer.

--Dummy: Has X-input from semi-finished-material receiving area and normal output to Maker.

--Maker: Has X-input from Dummy and WIP buffer, and normal output to the second buffer.

--Flexor: Has X-input from the second buffer and normal outputs to shipping areas A, B, and C.

Triggering mechanism: For A and C, trigger at Spindler, and for B, trigger at Dummy.

--A: Low @ 10 at Shipping Area "A".

--B: Low @ 20 at Shipping Area "B".

--C: Low @ 30 at Shipping Area "C".

6) RUNNING THE MODEL AND RECOMMENDATIONS:

Unit price (A) = $84,100,000/800 = $105,125

Unit price (B) = $31,800,000/1,600 = $19,875

Unit price (C) = $10,600,000/2,670 = $3,970

If we compare the machines with processing times of 3.0, 2.5, 2.0, and 1.5, we can get the following results:

--Comparison of machines with processing times of "3.0" and "2.5":

Incremental Expense: $4.400,000

Incremental Revenue: (520-440) * $105,125 + (1,057-880) * $19,875 +

(1,560-1,302) * $3,970 = $12,952,135.

This shows us that a quicker machine easily breaks even.

--Comparison of machines with processing times of "2.5" and "2.0":

Incremental Expense: $4,400,000

Incremental Revenue: (650-520) * $105,125 + (1,301-1,057) * $19,875 +

(1,950-1,560) * $3,970 = $20,064,050.

This analysis shows us that we are still better off.

--Comparison of machines with processing times of "2.0" and "1.5":

Incremental Expense: $4,400,000

Incremental Revenue: (800-650) * $105,125 + (1,600-1,301) * $19,875 + (2,670-1,950) * $3,970 = $24,569,775.

With this analytical analysis, we conclude that we should use the new Maker machine with the processing time of 1.5 minutes. We do not go further because the quicker machine with the processing time of 1.0 minute is unnecessarily expensive and does not bring us any extra benefit. In other words, we are recommending purchasing the Maker machine and using it in our second model.

Next, considering that demand is growing at a pace of 2% per year, we have to figure out whether we will have the same problem of nor meeting customer requirements. The unit price of the products are assumed to be the same as we are unable to predict price fluctuations in the future.

	Product A	Product B	Product C
Annual Output (first year)	800	1,600	2,670
" " (second year)	816	1,632	2,723
" " (third year)	832	1,665	2,777
" " (fourth year)	849	1,698	2,833
" " (fifth year)	866	1,732	2,890

Loss in the second year: (816-810) * $105,125 + (1,632-1,620) * $19,875 + (2,723-2,670) * $3,970 = $1,079,660.

Loss in the third year: (832-810) * $105,125 + (1,665-1,620) * $19,875 + (2,777-2,670) * $3,970 = $3,631,915.

Loss in the fourth year: (849-810) * $105,125 + (1,698-1,620) * $19,875 + (2,833-2,670) * $3,970 = $6,297,235.

Loss in the fifth year: (866-810) * $105,125 + (1,732-1,620) * $19,875 + (2,890-2,670) * $3,970 = $8,986,400.

So, we will lose a maximum of $9 million at the end of fifth year. Our loss is 866 - 810 = 56 units of A, 1,732 - 1,620 = 112 units of B, and 2,890 - 2,670 = 220 units of C. Since the differences are not very high, and since a new Maker machine is costing $4.4 million for a 0.5 minute reduction below 3.0 (which is a lot of money), we are recommending to use our current Maker machine which has a processing time of 3.0 minutes and a setup time of 5.5 minutes and which is replaced with the new Maker machine.

Our current output with the old Maker machine which we are offering to use is 405 units of A, 820 units of B, and 1,218 units of C which are sufficient for future increases of demand. Accordingly, there is no need to buy a second brand new Maker machine for the increases of demand in the future. In other words, we will use the new Maker machine and when it does nor fulfill customer requirements, we will add our old Maker machine as a second one to the model.