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NOVA INCORPORATED: E-CASE
THE EXPERIMENT
Working Paper #9403-38

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NOVA MANUFACTURING COMPANY: E-CASE
THE EXPERIMENT

During the past eight months, Fisher's management team has had time to react to Market Opinion Associates' recommendations. The MAO report highlighted three marketing areas that needed improvement: **delivery reliability** - promised shipments were often late; **technical support** - customers in some regions would need more technical support if market share was to increase; **product breadth** - product variations were required to penetrate new market segments. Based on these findings NOVA's Chief Information Officer, Julia Anderson, led a task force that recommended several changes to NOVA's manufacturing, logistics and information systems. Once the task force proposal was modified and accepted, Anderson would be given the task of implementing the plan.

The plan was to be executed in two phases. In the first phase, temporary changes would be enacted to see if the market would actually respond to improved service to the extent forecast by the MAO study. In the second phase, permanent resources would be committed to increase manufacturing capacity, to build new software for controlling material flow, and to restructure company operations. The exact nature and extent of these investments would depend upon the results of the first phase experiment.

To ensure an adequate test of MOA's market conjectures, the management team decided to run the first phase experiment for six months. There were three major components to the experiment. First, the market study clearly showed that customers wanted products delivered both faster and more reliably than NOVA had in the past. To satisfy this requirement, the task force recommended cutting delivery lead times significantly and guaranteeing that NOVA would "ship on-time or the product is free." Since on-time delivery was then running at 73%, this commitment represented a substantial potential risk to NOVA. Three immediate actions were proposed to meet this target in the short-run. First, additional finished goods would be placed at each warehouse to cover demand during their reorder lead time. Second, ample raw material would be kept at each factory so that the chance of running out would be minimal, and purchasing preference would be given to suppliers who guaranteed delivery date and agreed to incur NOVA's "product is free" expenses if they caused a missed shipment. Finally, manufacturing was authorized to "keep the pipeline full" by working overtime if needed to respond to variations in product demand.

Anderson's experiment with an on-line, real-time, world-wide, order receipt and shipping system would also be put into operation. The system gave factory production planners visibility of daily sales and shipments so that they could release production only to replenish inventories depleted by actual customer sales. Rather than focusing on the factory operating efficiency, they were instructed to keep lot sizes small so that cycle stock would be low. In addition, electronic receipt of orders from customers was expected to allow NOVA to smooth production and build anticipation stocks when appropriate. Key customers had committed to pay for materials and labor for any order canceled within two weeks of planned delivery. Because of this, NOVA's financial risk in stocking high volume products was small.

The distribution task force previously established that both demand variability and delivery lead time could be reduced substantially by changing the practices which govern the flow of materials from the central warehouse to the regional distribution centers. The existing communications system induces a full day delay in the picking cycle at both the Cincinnati and London warehouses. Then once picked, 75% of all orders remain in the warehouses for a full day before they are packed for shipment. Finally, when orders are received at a regional warehouse, they typically wait a day or more before product is available for shipment to a customer. In combination, these delays are significant. By using improved software and operational practices, and by working closely with their transportation provider through EDI, Anderson predicted that NOVA's lead times could be reduced to the levels given in Table 1.

Revised Lead Time From Central To Regional Warehouses

			From Central Warehouse			
			North America		**Europe**	
			Min. (Days)	Max. (Days)	Min. (Days)	Max. (Days)
To Regions	**N. America**	regular	2	2	2	4
		expedite	1	1	1	2
	Europe	regular	2	4	2	2
		expedite	1	2	2	3
	Eastern Bloc	regular	2	4	2	3
		expedite	2	2	1	1
	S. America	regular	2	4	3	5
		expedite	2	2	2	2
	Asia/Pacific	regular	3	4	3	4
		expedite	1	2	2	2

Table 1.

The second component to the phase-one experiment was to improve the technical support provided to customers. Anderson's staff had developed a prototype software system to allow both OEM and distribution customers to select appropriate products to meet their functional requirements. This PC based system is easily operated by a computer novice. It is menu driven with a graphical user interface and extensive on-line help. If required, Anderson had committed to create multi-lingual versions of this system, and to train NOVA personnel and customers in the use of this software. In addition, technical marketing staff in each region could be trained to join with an IS staff member to provide "hot line" and on-site assistance in the use of the software.

The last component of the six-month experiment was an ingenious proposal by Engineering to increase the breadth of the product line. By changing the design of each of the current products in a relatively minor way, it was possible to present hundreds of product variations to the market. With the change, the plants continued to make 10 base products, but each regional warehouse could then quickly and cheaply customize the product for their local needs. Typically, customer's installation costs were reduced by the design change.

There were some reservations about the plan in the management team. Larry Judge, the Chief Financial Officer, was concerned that profitability would suffer. He predicted that with the growth of inventory, holding costs would increase. Furthermore, with reduced lot sizes and increased overtime, operating costs would rise dramatically. Finally, he was most alarmed by the financial exposure of the "on-time-or-free" guarantee. As a result, the team decided to extend this guarantee only to customers in the United States and Europe. Customers elsewhere were promised that on time delivery would improve to 95%, and guaranteed that product would be free if it were more than 5 days late. With this modification, the management team agreed to execute all three components of the experiment.

PHASE I

The experiment has just now completed its six month. As John Fisher reviewed the results, he realized that he must act quickly to sustain a substantial growth in sales and to regain control of operating expenses. As he examined the progress report, he made the following observations.

First, the market had indeed responded to the improvements in supply, service and product range. There were important new accounts, and sales to established accounts had grown as well. The greatest improvement occurred in the United States and Europe where sales increased by 41% and 39%, respectively. On time delivery improved in these regions to 98% and 97% of unit sales. Elsewhere, demand increased between 18% to 34%. Overall, sales had increased by 36% and were still climbing. Table 2 gives the present daily sales rates by product type for North America and South America.

Second, although sales had increased dramatically, costs had risen as well. As Judge predicted, inventory costs and operating costs rose at a faster rate than revenues. The United

States factory was now running at 120% of capacity and the resulting overtime had increased labor costs by almost 50%. A similar situation existed in Europe where the factory was running at 117% of its rated capacity. Sales projections based on marketing data indicate that each factory will have to operate at over 200% of capacity within 6 more months if all demand was to be met. The workforce was already showing signs of wear, and an alarming increase in scrap rate was driving both material and labor cost variances at both plants. Clearly, something had to be done to provide additional capacity in a more effective way.

Current Estimated Daily Demand Rates (Units)

Part Numbers	North America	South America	Total
1	50.07	15.58	65.65
2	27.6	7.8	35.4
3	5.18	4.85	10.03
4	7.09	2.33	9.42
5	1.12	1.07	2.19
6	0.64	2.46	3.1
7	1.44	7.73	9.17
8	0.24	0.99	1.23
9	0.09	0.47	0.56
10	0	0.22	0.22
Total	93.47	43.5	136.97

Table 2

To achieve the improved fill rates, inventories in all locations for all products had risen substantially; finished goods had almost tripled. Fisher believed that inventory levels could be reduced while the high service levels were maintained. But to do this he knew that plant capacity would have to be increased, scheduling procedures revised, quality problems eliminated, workload reallocated between factories, and new inventory policies developed and implemented.

Transportation costs had also risen. Because of demand variation, it was often necessary to ship by air to fulfill the on-time promise. Trans-shipments between stocking locations also increased and premium freight was often used to ship products between Europe and the United States. Fisher realized that new transportation partnerships and a revised production strategy were needed to control these increased operating costs.

Fisher's third observation pertained to the strategic and tactical value of his IS group. The new software to support the technical sales had been a major contributor to revenue growth in South America and in Eastern Europe. A major new customer was signed in South America and three others in Poland because of the design assistance available through the software. The information system that supported production planners with real time inventory data was critical in producing the right products and allocating them to the right regional warehouses. Nevertheless, while more product was sold and better production decisions were made with these new information systems, production costs were increasing in unanticipated ways. Thus, Fisher realized that to take full advantage of new information technologies, the manufacturing equipment and factory procedures would have to be modified.

Fisher's final observation related to changes in product design and assembly. The new design that allows product customization to occur at a regional warehouse helped increase sales without raising production costs. Fisher realized that the product-family-modular-design concept would be an important one to exploit both now and in the future. With these observations in mind, Fisher prepared a memo for his staff that outlined the tasks that now needed to be completed so that NOVA might move forward quickly.

FISHER'S MEMO

After summarizing his interpretation of the phase-one experiment, Fisher asked his staff to conduct further analyses and present their findings at the following week's meeting. One portion of the analysis was assigned to Jerry Jackson, the Cincinnati plant manager. The current manufacturing plan called for the production of products 1, 2, 3, 6, 8 and 9 in Cincinnati and products 1, 2, 4, 5, 7 and 10 in London. While tooling costs and operating efficiencies are improved by this plan, customer service suffers and transportation costs and inventory costs are higher than they need be. Fisher asked Jackson to evaluate the impact of producing all products in each plant. Specifically, Fisher was considering manufacturing all products required to meet North American and South American demand in the Cincinnati plant, while servicing all other demand out of London.

Jackson already had realized that the Cincinnati operating environment needed to be improved. First, he found that while individual set-up times were short, too large a fraction of total time was now consumed by set-up due to the new smaller lot sizes. Second, he knew that if run rates could be increased, then overtime could be reduced. He investigated new equipment. One type had significantly faster set-up times than currently achieved in Sector 2; but, it also had slower run rates. Another type had much greater set-up time, but had considerably higher run rates. Operating data on the current Cincinnati equipment are given in Tables 3.1 through 3.3. Comparable data on the new equipment are given in Tables 4.1 through 4.5. Cost and financial data for all machines are found in Table 5.

Data from the past six months revealed that Sector 1 processes were out of control. The scrap problems arose from a difficulty in positioning the components precisely. The labor utilization rate was lower than expected because of an imbalance in the workload between sectors. Bill Cochran, the plant's chief manufacturing engineer, has proposed to fix the problems by buying a robot to replace the operator. The robot is highly accurate, but will require some increased operating expenses for tooling and maintenance. Data relating to this robot are also found in Tables 4 and 5.

As part of the six month experiment, Jackson had reduced the number of suppliers for key components to just two. Throughout the experiment, he kept careful records concerning scrap rates at each operation, and performed a thorough analysis of all scraped parts. Jackson observed a large increase in scrap due to material defects and noted that the rate varied depending upon the source of supply. He noted that the defects due to incoming material had increased after the product redesign, and he found that the material purity was markedly higher from one supplier. His procurement staff, being concerned about material cost, recommended that all purchases be made from one supplier. Unfortunately, the lower purity was coming from the low-price supplier. Data found in Table 6 give the price and scrap rates for both suppliers.

One increase in operational expense was traced to a rather aggressive preventive maintenance program, and Judge's audit staff had recommended cutting back the program in order to reduce labor cost. Jackson's data, however, showed that while maintenance costs had increased, scrap rates and random equipment failure rates had declined because of the program. Cochran is adamant that PM activities be increased rather than be eliminated. Data on the costs and benefits of the preventive maintenance program are given in Table 7.

Current Operating Characteristics
Sector 1 Manual

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	0.7	1.3	0.08%	1,000	60
2	0.8	1.3	0.08%		
3	0.8	3	0.17%		
4	1.2	3.8	0.17%		
5	1.3	3.8	0.42%		
6	0.9	3.8	0.33%		
7	1.4	4	0.42%		
8	0.9	3.8	0.33%		
9	1	3.8	0.33%		
10	1.7	1.7	0.42%		

Table 3.1

Current Operating Characteristics
Sector 2 Machine 1

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	2.9	20	0.50%	900	57
2	3.1	20	0.50%		
3	3.1	25	1.50%		
4	3.5	25	1.80%		
5	3.5	30	1.70%		
6	3.4	30	2.00%		
7	3.8	30	2.00%		
8	3.7	30	2.00%		
9	4	30	2.00%		
10	4	30	3.00%		

Table 3.2

Current Operating Characteristics
Sector 3 Machine 1

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	1.1	1.9	0.12%	1,000	60
2	1.2	1.9	0.12%		
3	1.2	4.5	0.26%		
4	1.8	5.6	0.26%		
5	2	5.6	0.63%		
6	1.3	5.6	0.50%		
7	2	6	0.63%		
8	1.4	5.6	0.50%		
9	1.5	5.6	0.50%		
10	2.5	6.4	0.63%		

Table 3.3

Available Equipment Operating Characteristics
Sector 1 Robot

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	0.1	0.3	0.02%	10,000	300
2	0.2	0.3	0.02%		
3	0.2	0.6	0.03%		
4	0.2	0.8	0.03%		
5	0.3	0.8	0.08%		
6	0.2	0.8	0.07%		
7	0.3	0.8	0.08%		
8	0.2	0.8	0.07%		
9	0.2	0.8	0.07%		
10	0.3	0.9	0.08%		

Table 4.1

Available Equipment Operating Characteristics
Sector 2 Machine 2

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	2.76	18	0.47%	600	62
2	2.85	18	0.47%		
3	2.87	24	1.40%		
4	3.22	26	1.67%		
5	3.25	28	1.58%		
6	3.21	30	1.86%		
7	3.4	30	1.86%		
8	3.5	30	1.86%		
9	3.8	30	1.86%		
10	3.8	30	2.79%		

Table 4.2

Available Equipment Operating Characteristics
Sector 2 Machine 3

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	4.4	2	0.11%	3,000	50
2	4.5	2	0.11%		
3	5	2	0.33%		
4	5.1	2.5	0.40%		
5	5.1	2.5	0.37%		
6	5.4	2.5	0.44%		
7	5.5	3	0.44%		
8	5.7	3	0.44%		
9	6	3	0.44%		
10	6	3	0.66%		

Table 4.3

Available Equipment Operating Characteristics
Sector 2 Machine 4

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	2	27	0.37%	750	65
2	2.1	27	0.37%		
3	2.1	33	1.10%		
4	2.5	33	1.31%		
5	2.5	40	1.24%		
6	2.4	40	1.46%		
7	2.7	40	1.46%		
8	2.7	40	1.46%		
9	2.9	40	1.46%		
10	2.9	40	2.19%		

Table 4.4

Available Equipment Operating Characteristics
Sector 3 Machine 2

Part Numbers	Run Times (min/unit)	Setup Times (min)	Scrap Rates	MTBF (min)	MTTR (min)
1	0.2	0.4	0.03%	4,000	35
2	0.2	0.4	0.03%		
3	0.2	0.9	0.05%		
4	0.4	1.1	0.05%		
5	0.4	1.1	0.12%		
6	0.3	1.1	0.11%		
7	0.4	1.2	0.12%		
8	0.3	1.1	0.11%		
9	0.3	1.1	0.11%		
10	0.5	1.3	0.12%		

Table 4.5

Equipment Costs And Financial Data ($US)

		Book Value	Purchase Price	Salvage Value	Monthly Depreciation	Monthly Maintenance Costs	Initial Tooling Costs	Ongoing Monthly Tooling Costs
Sector 1	Manual *	38,000	78,000	26,000	650	180	10,400	610
	Robot		96,000		800	240	12,000	800
Sector 2	Machine 1 *	1,260,000	1,800,000	1,450,000	15,000	4,700	161,000	14,500
	Machine 2		1,900,000		15,800	3,900	165,000	14,000
	Machine 3		1,050,000		8,750	2,300	53,000	9,500
	Machine 4		2,400,000		20,000	4,900	170,000	10,500
Sector 3	Machine 1 *	427,000	610,000	400,000	5,000	2,100	45,000	5,200
	Machine 2		780,000		6,500	800	45,000	4,800

*Currently installed
- Book Value pertains only to equipment currently installed.
- Initial Tooling Costs for currently installed equipment reflect the costs to initiate production of products 4, 5, 7, and 10 in Cincinnati.
- Monthly maintenance costs assume no preventive maintenance is performed.

Table 5

Component Costs And Purities

Component Number	Supplier 1		Supplier 2	
	Price	Purity	Price	Purity
1	$49.46	98.20%	$51.03	99.90%
2	$61.23	99.10%	$63.68	99.90%
3	$80.07	97.50%	$81.67	99.90%
4	$17.27	97.70%	$19.00	99.90%
5	$22.45	98.60%	$24.70	99.90%
6	$29.36	96.90%	$32.29	99.90%
7	$6.28	98.50%	$6.59	99.90%
8	$8.16	97.90%	$8.49	99.90%
9	$7.85	96.50%	$8.56	99.90%
10	$8.64	99.50%	$9.41	99.90%

Table 6

Cochran has also proposed to replace the current machine in Sector 3. While it is not now a bottleneck, he believes it will become one in the near future if the plant output is increased. Operational data on both machines are found in Tables 3 and 4.

Jackson's material planner, who recently completed a course on production scheduling and inventory planning, has proposed to modify NOVA's just-in-time production process. He is urging Jackson to make better use of information available through the new EDI system to build inventories that they can "see" the customers will need prior to the receipt of firm orders. With customers' demands for better service, NOVA's just-in-time, small lot size production philosophy creates highly variable work loads at the plant with a resulting need for substantial overtime. The material planner proposes to maintain finished goods inventories in some high volume products in order to smooth workloads and reduce operating costs.

To prepare his report for Fisher on the manufacturing capacity required to service all demand from North and South America, Jackson needs to analyze the marketing and operational data further. Specifically, he must model and evaluate the operational and cost consequences of various production and equipment plans. He also wants to study the impact of the new production control and inventory planning concepts advocated by his materials manager.

Costs And Benefits Of Preventive Maintenance (PM)

		Without PM			With PM					
		MTBF (Minutes)	MTTR (Minutes)	Scrap Rates **	MTBF (Minutes)	MTTR (Minutes)	Scrap Rates **	Minutes Between Scheduled PM	Duration of PM Activity (Minutes)	Incremental Annual Cost ($US)
Sector 1	Manual *	1,000	10	.0008->.0042	4,620	10	.0004->.0021	1,440	15	(150)
	Robot	10,000	75	.0002->.0008	42,000	75	.0001->.0004	1,440	50	4,100
Sector 2	Machine 1 *	900	57	.0050->.0300	2,815	57	.0030->.0150	1,440	30	3,000
	Machine 2	600	62	.0047->.0279	2,906	50	.0028->.0134	1,440	30	(900)
	Machine 3	3,000	50	.0011->.0066	11,412	50	.0007->.0031	1,440	30	(1,000)
	Machine 4	750	65	.0037->.0219	3,428	50	.0024->.0110	1,440	30	4,500
Sector 3	Machine 1 *	1,000	60	.0012->.0063	4,340	60	.0006->.0031	1,440	30	1,000
	Machine 2	4,000	35	.0003->.0012	13,200	35	.0002->.0006	1,440	30	2,300

* Currently Installed.
** In general, scrap rates under a preventive maintenance policy are between 50% and 60% of the no-PM case.
*** Does not include the effect on cost of scrap rate reduction.

Table 7

After notifying his management team of their assignments for the following week's meeting, Fisher contemplates taking a short vacation, and, perhaps, reacquainting himself with the game of golf. As he was preparing to leave, he received a memo from Claudio Spiguel requesting authority to purchase all product for South America from a local source. After reading the memo, he sent copies of it to his management team asking them for advice, and informing them that they should be prepared to discuss it at next week's meeting.

Attached are copies of Spiguel's memo to Fisher along with memos Spiguel received earlier from Fisher and Judge.

NOVA MANUFACTURING, INC.
"Your Global Assembly Supplier"

MEMORANDUM

TO: John Fisher, CEO

FROM: Claudio Spiguel, President, Nova South America

DATE: July 25, 1994

SUBJECT: Maintaining Customer Service and Improving Nova Profitability

Attached is a copy of your recent memo on Customer Service and cost as well as a copy of Larry Judge's memo on improving return on investment. Sometimes it takes a combination of reminders like this to shake us loose from old habits . . to drive home the point that we can't make marginal changes if we seek major improvements. Let me explain. First, I am sure that my South America operations were a significant contributor to your memo. Recently we have maintained generous amounts of inventory of finished goods in an attempt to provide superior service to our customers. As you observed from our monthly performance reports, we have succeeded in providing excellent service, which has resulted in a substantial growth in our business. We have found that deliveries from Cincinnati and London are more reliable, too. Our increase in service has been driven by inventory investment that resulted from increasing my cycle stocks and raising my reorder points to "safer" levels. While I knew at the time I made the decision to increase stock levels that costs would rise, I believed that it was the right thing to do for our customers.

Then later, Larry Judge's memo on RONA arrived. It reminded me that customer service was not the only goal for Nova managers. Making a "fair profit" for our share holders on the assets they had provided us with was also important. Since inventories are the greatest of the assets under my local control and their holding costs contribute heavily to our operating expense, inventory reduction is my key lever for RONA improvement. I am torn between the goals of reducing inventory and maintaining a high level of customer service. When I improve one the other gets worse.

When I shared this dilemma with a cousin who runs a manufacturing firm here in Sao Paulo, he asked for a sample of each of the products that Nova sells in South America. After reverse engineering our ten products, he designed a manufacturing process to build each and lined up a set of local suppliers. He has now offered me the following contract. If I guarantee to purchase all Nova products sold in South America during the next 5 years from him, he will make the capital investment required to manufacture them. He will sell them to us at our current Nova transfer price, quoted in dollars to eliminate Nova's exposure to Brazilian currency fluctuation, and he will guarantee the price for the 3 years (which Cincinnati will not do for me). Moreover, he will require no minimum order size and he will guarantee 1 day delivery of any order quantity up to 2% of annual demand. Finally, he will pay all transportation costs and will guarantee that product quality will meet or exceed Nova's existing standards.

This is the answer to a prayer. He will own the pipeline stock, and I will need only 2 days of safety stock and about a day of cycle stock. My fill rates will remain very high and my transportation costs will be negligible. From your perspective, the risk of profit erosion from the wild currency fluctuations that we have experienced in recent years will be eliminated. I estimate that my RONA bonus will exceed 40%, and he feels that he will make an acceptable profit. This is a win-win-win situation.

Do I have your approval to sign the contract and proceed with this new alliance?

Attachments: 2

NOVA MANUFACTURING, INC.

"Your Global Assembly Supplier"

MEMORANDUM

TO: All Nova Distribution Center Managers

FROM: John Fisher, CEO

DATE: July 1, 1994

SUBJECT: Customer Service and Cost

In the last two weeks I ran into a board member and then a college classmate, who each informed me that during the past 6 months their companies had increased their purchases of our products. They were amazed at the increase in our ability to serve them given that in the past we always were late and erratic in our shipping performance. Without having details on products, regions and dates, they assured me that what was a problem was now a real strategic advantage for us. They wondered how we moved from last to first as a supplier in their industry.

While you all should be commended for following my instructions to improve customer service, recognize that our costs have risen to the point where the increased demand and service reduces profitability. Let me be blunt. Unless we can maintain the improved service levels at substantially lower operating costs, we will be out of business. You must reduce your costs-transportation, holding, and other overhead costs. At the management committee meeting this month, we will review your plans and progress.

Attachment 1

NOVA MANUFACTURING, INC.

"Your Global Assembly Supplier"

MEMORANDUM

TO: All Nova Distribution Center Managers

FROM: Larry Judge, CFO

DATE: July 8, 1994

SUBJECT: Lean Production

To survive in our increasingly competitive business environment, it is imperative that we all strive continuously to improve financial performance. Return on net assets, RONA, is a traditional and important measure of the effectiveness with which productive assets are deployed by a company's management. I have therefore decided to establish last year's RONA numbers as a benchmark for company performance. Hereafter, monthly RONA numbers at each location will be used as a barometer to measure performance improvement as we move forward during the year.

I will calculate your 1993 RONA and will tie your compensation to your ability to improve it in 1994. The company improvement goal of 10% *must be* met by all locations. Managers who exceed this goal will receive a salary bonus percentage equal to twice their percentage improvement beyond 4%. I know you will each do the right thing.

Attachment 2

Assignment 1. Analyze the data corresponding to the past six month's demand for the ten products shipped in North and South America. Conduct appropriate Pareto analyses. Can you identify the impact of the variability in the demand for capacity caused by certain customers? What trends or patterns do you see in the data?

Assignment 2. Select the equipment plan for each sector, the supplier plan for each component, and the preventive maintenance plan that you would recommend to Fisher for the Cincinnati factory to meet the market requirements. Justify your selection first by performing a cost analysis. Calculate the net present value of your proposed plan.

Assignment 3. Verify your plans through the operational testing of the proposed system. First, carefully state your production control algorithm and inventory policies. Second, test your equipment, supplier, and maintenance plans and your production and inventory policies using the simulation software that has been provided for your use.

Assignment 4. Prepare a presentation for Fisher summarizing your conclusions and recommendations for meeting demands. This should include a summary of the capital expenditures that will be required through time, supplier sourcing recommendations, maintenance policies, and production and inventory policies. A financial analysis will also be required.

Assignment 5. What recommendations would you give Fisher concerning Spiguel's proposal? Why? What are the consequences of accepting Spiguel's plan?