THE NOVA GAME:

A TUTORIAL

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Nova Demo
Startup Instructions

The Nova demo program requires Windows 3.1 and Excel 4.0 (both are installed in the Business School labs). Since the program is large, be sure to terminate any other active applications before starting it. For those of you who may want to run the program at home or at work, beware that using anything smaller than an 8-meg 486 will result in *very* poor performance.

Option 1: Using The Business School Network

1. Start Windows
2. Create a directory on the C: drive called GAMEDEMO (using File Manager)
3. Copy the entire contents of directory F:\ANY_USER\ to C:\GAMEDEMO\
4. Start Excel
5. Open file C:\GAMEDEMO\NOVADEMO.XLW

Option 2: Using A Diskette

1. Obtain a copy of the Nova diskette - several have been placed on reserve in the Business School Library and at the front desk at the Dearborn facility
2. Start Windows
3. Create a directory on the C: drive called GAMEDEMO (using File Manager)
4. Copy the contents of the diskette into this directory
5. Execute the file INSTALL.BAT (from the File Manager, double-click this file in C:\GAMEDEMO)
6. Start Excel
7. Open file C:\GAMEDEMO\NOVADEMO.XLW

If you wish to run Nova at home or at work, obtain a reserved diskette and copy it to your own diskette. Then follow the Option 2 instructions above.

The Nova Game

Introduction

The Nova Game is a computer-based business simulation game designed to be used in conjunction with the Nova A case. It's purpose is to enhance the student's intuition about logistics decision-making within a global manufacturing and distribution environment. In particular, the game is intended to illustrate how apparently rational decisions about production, distribution and procurement at the divisional level play out against each other at the organizational level. Bad things can happen, even when well-intentioned people act in apparently rational ways, and students are led to question the nature of the management control systems which define rationality - perhaps the rules which govern the cooperative arrangements between players needs to be re-examined...

The Game

Students are divided into teams, as follows:

- five teams responsible for managing each of Nova's five Regional Distribution Centers (DC's)
- two teams responsible for managing each of Nova's Factories
- one or more teams responsible for tracking and assessing performance at Nova Corporate

The seven teams representing the DC's and Factories each make daily operating decisions, and then carry out these decisions, at seven computer terminals. Factories, for example, receive the day's orders from the DC's, plan and execute a daily production run, decide which of the DC's orders will be fulfilled, receive raw material from their suppliers, and place orders to replenish their raw material inventories. DC's receive incoming shipments from the Factories, ship goods to their customers, and place orders with the factories to replenish their inventories. In both cases, historical operating information and current performance measures in the form of operating and financial results are available to guide decision-making.

Play is synchronized at the Factories and DC's - when all of the above activities have been completed for a given day, products and orders move between the DC's and Factories as requested, and the next day begins.

At the end of each day, certain operating and financial data is consolidated at an organizational level on another computer, and the team(s) representing Nova Corporate assess the day's results. If necessary, they can intervene by calling meetings, issuing directives, etc.

A Nova Game Tutorial

The following pages describe a day in the life of a Factory management team as they work through their activities on the European Factory computer. The operation of the DC's is analogous to the operation of a Factory in most ways, although DC's are somewhat simpler due to the absence of a production activity. Students should have little difficulty in adapting to the DC environment once the Factory operation has been mastered.

Play begins on Day 1 at the Main Menu, illustrated on the following page. Take a moment to familiarize yourself with the layout of this screen, paying particular attention to the activity buttons on the circular arrow beginning with "Order Entry" and ending with "Call It A Day". As a general rule, it's best just to follow the indicated sequence of activities. To help you to remember where you are in the cycle, the captions in the activity buttons are crossed out and grayed once their activities have been performed. Also, an information box always indicates the next action to be performed.

Each activity button has at least one *report button* beside it. Clicking these report buttons produces information about the outcome of the associated activity. Try a few of these now, always clicking a button called "Done" on the report screen to return to the Main Menu.
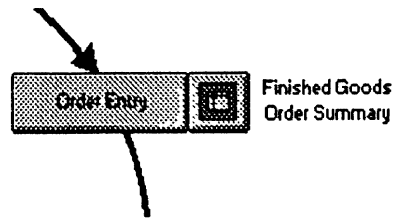
Three other useful buttons are present on the Main Menu - these are:

- the *Overall Financial Results* button - clicking this button produces a cumulative statement of financial results since the beginning of play
- the *Review/Change Forward Buying Decision* button allows you to speculate on the foreign exchange market with the funds that you use to buy raw materials abroad. More about this option later.
- the *Expert System Express* button completes any outstanding activities for the current day using Expert System rules for each operating decision. You'll learn more about these rules as each activity is discussed.

The remaining two buttons are reserved for the gamemaster. Both require passwords.

Each of the main activities will now be described. As the discussion proceeds, you will be asked to perform certain actions. Please resist the urge to experiment at this point - just follow along and try not to omit anything. The tutorial walks you through the entire first day, and then allows you to play days two through six on your own. It also provides you with the financial results that the Expert Systems obtained after the six days of play, so if you're so inclined, you can try to "beat the experts".

3

The Main Menu

Indicates the day

Indicates the next action to be performed today

Report Buttons - click to see indicated report

Click here to finish the current day using Expert Systems

Click here to view the cumulative financial performance of the factory since the beginning of play

Action Buttons - click to perform indicated action

Click here to view or alter foreign currency decisions

Click here to terminate play

Reserved for Gamemaster

Novis Europe - European Manufacturer

Day: 1

Receive and enter orders from your customers by clicking the "Order Entry" button.

Finished Goods Order Summary

Order Entry

Call It A Day

Production

Factory Daily Cost Report

Production Report

Shipping

Central Warehouse Inventory And Shipping Report

Central Warehouse Performance Report

Receiving

Procurement

Order Summary

Raw Material Inventory Report

Overall Financial Results

Payment/Change Foreign Buying Decision

Quit

Order Entry

Finished Goods
Order Summary

Click the Order Entry button to receive incoming orders from the DC's. After a brief delay, processing is complete and you may click the "Finished Goods Order Summary" button to view the day's incoming orders. The following screen will appear:

Nova Europe - European Manufacturer

Day: 1

Regional Warehouse

Finished Goods Order Summary		Nova U.S.		Nova Europe		Nova Eastern Block		Nova S.A.		Nova Asia Pacific	
		Regular	Expedite	Regular	Expedite	Regular	Expedite	Regular	Expedite	Regular	Expedite
	1	0	0	45	0	33	0	0	0	12	0
	2	0	0	63	0	27	0	0	0	9	0
	#N/A										
	4	0	27	0	12	0	12	0	9	0	3
Product	5	0	6	0	9	0	6	0	3	0	3
Number	#N/A										
	7	0	3	0	3	0	3	0	6	0	12
	#N/A										
	#N/A										
	10	0	0	0	0	0	0	0	0	0	3
Total Orders Received Today		0	36	108	24	60	21	0	18	21	21

This screen summarizes today's orders from the DC's. Note that there are two kinds of orders: regular and expedite. Today, for example, your Factory received orders from the Nova US Distribution Center for 27 Part 4's, 6 Part 5's, and 3 Part 7's. Since Nova Factories and DC's are linked by EDI, these orders were transmitted to your Factory (Nova Europe) overnight, so they represent requests made at the DC's yesterday.
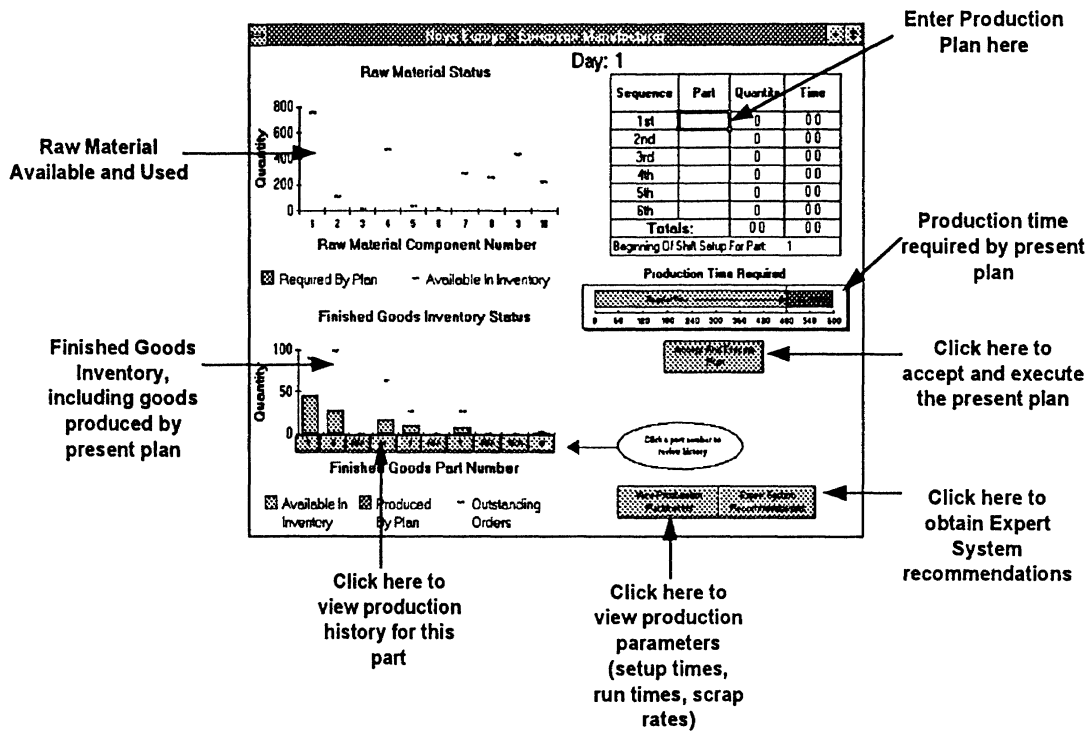
Click the "Done" button to return to the Main Menu - order processing is now complete, but you can recall the orders by clicking the Finished Goods Order Summary report button located beside the Order Entry button. Try that now, then return to the Main Menu by clicking the Done button on the report screen.

Production

Factory Daily
Cost Report
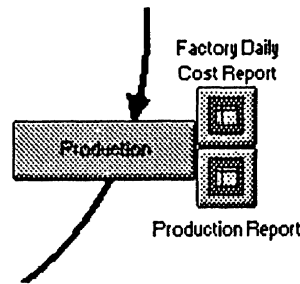
Production Report

Click the Production activity button to plan and execute today's production run. After a brief delay, the Production Planning screen appears. Take a moment to become familiar with this screen:

The Production Planning Screen

Day: 1

Raw Material Status

Raw Material Available and Used

Raw Material Component Number

☒ Required By Plan   ⁻ Available In Inventory

Finished Goods Inventory Status

Finished Goods Inventory, including goods produced by present plan

Finished Goods Part Number

☒ Available In   ☒ Produced   ⁻ Outstanding
   Inventory   By Plan   Orders

Sequence	Part	Quantity	Time
1st		0	0 0
2nd		0	0 0
3rd		0	0 0
4th		0	0 0
5th		0	0 0
6th		0	0 0
Totals:		0 0	0 0

Beginning Of Shift Setup For Part   1

Production Time Required

Enter Production Plan here

Production time required by present plan

Click here to accept and execute the present plan

Click here to obtain Expert System recommendations

Click here to view production history for this part

Click here to view production parameters (setup times, run times, scrap rates)
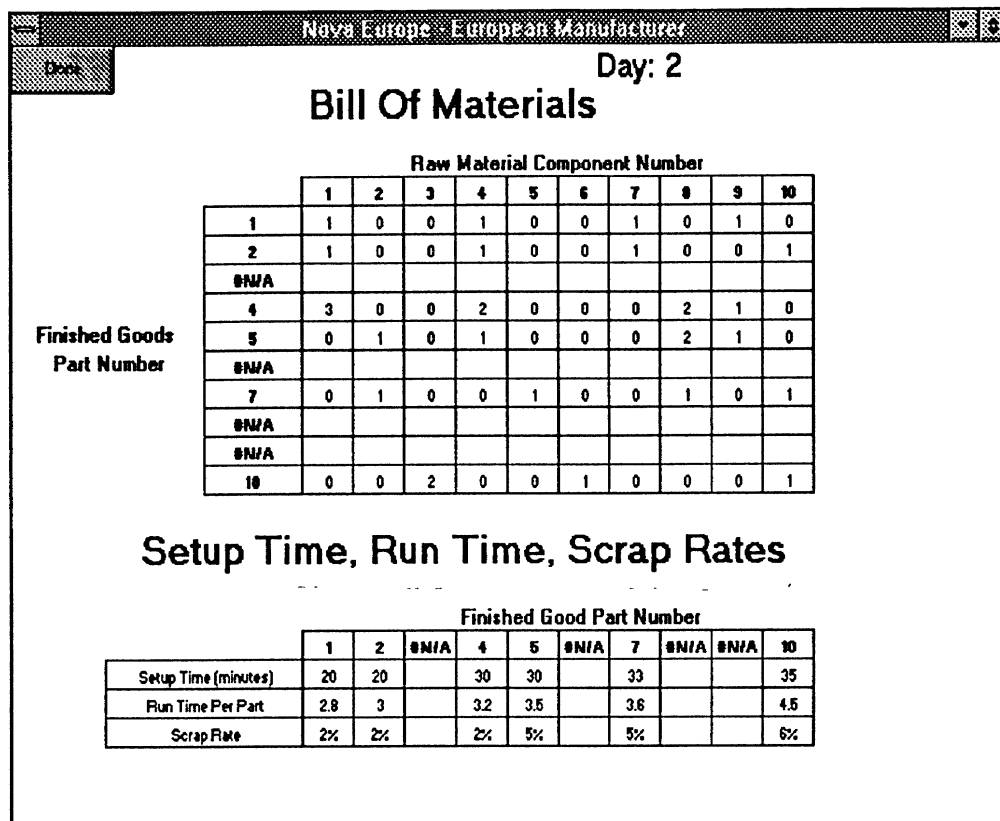
Your task is to decide what *Parts* should be manufactured today, and in what *quantities* and in what *sequence*. You enter your plan in the two middle two columns of the table in the upper-right-hand corner of the screen (on your terminal, they will be colored light blue). Before describing how to do this, however, lets look at some of the information on the screen to help you with this decision.

One important constraint in your production planning is the amount of raw material available. In the upper left-hand-corner of the screen is a chart labeled "Raw Material Status". The small vertical lines on the chart indicate how many of each of the ten raw material components is available. As you enter your plan, a bar will appear indicating how much of each raw material component your plan requires.

Another important constraint is time. Just below the grid where you enter your plan is a bar chart entitled "Production Time Required". Notice that there are 480 minutes available in a regular shift, and an additional 120 minutes in an overtime shift. As you enter your plan, this chart will change to reflect the amount of time your plan consumes. The same information is also available in the right-hand column of the Production Plan grid.

Click the button called "View Production Parameters" to display the following chart:

Day: 2
Bill Of Materials

Raw Material Component Number

Finished Goods Part Number		1	2	3	4	5	6	7	8	9	10
	1	1	0	0	1	0	0	1	0	1	0
	2	1	0	0	1	0	0	1	0	0	1
	#N/A										
	4	3	0	0	2	0	0	0	2	1	0
	5	0	1	0	1	0	0	0	2	1	0
	#N/A										
	7	0	1	0	0	1	0	0	1	0	1
	#N/A										
	#N/A										
	10	0	0	2	0	0	1	0	0	0	1

Setup Time, Run Time, Scrap Rates

Finished Good Part Number

	1	2	#N/A	4	5	#N/A	7	#N/A	#N/A	10
Setup Time (minutes)	20	20		30	30		33			35
Run Time Per Part	2.8	3		3.2	3.5		3.6			4.5
Scrap Rate	2%	2%		2%	5%		5%			6%

This report shows the Bill Of Materials and the Setup, Run Time and Scrap rates for each Finished Goods Part. Click the "Done" button to return to the Production Planning Screen.

A final important input to your production decision will be the amount of each part presently in inventory compared to the number of outstanding orders. This information is provided in the chart in the lower-left-hand corner of the Production Planning Screen. The small vertical bars indicate the number of outstanding orders, and the shaded bars indicate the quantity of each part on hand. As you enter your plan, these bars will be extended upward accordingly. Ideally, of course, you would like the bars to at least meet the lines every day, since this would mean that all outstanding orders could be satisfied.

The part labels on this chart are buttons which, when clicked, show production history data for that part during the past ten days of play. Click the button labeled "1" to display the following screen:
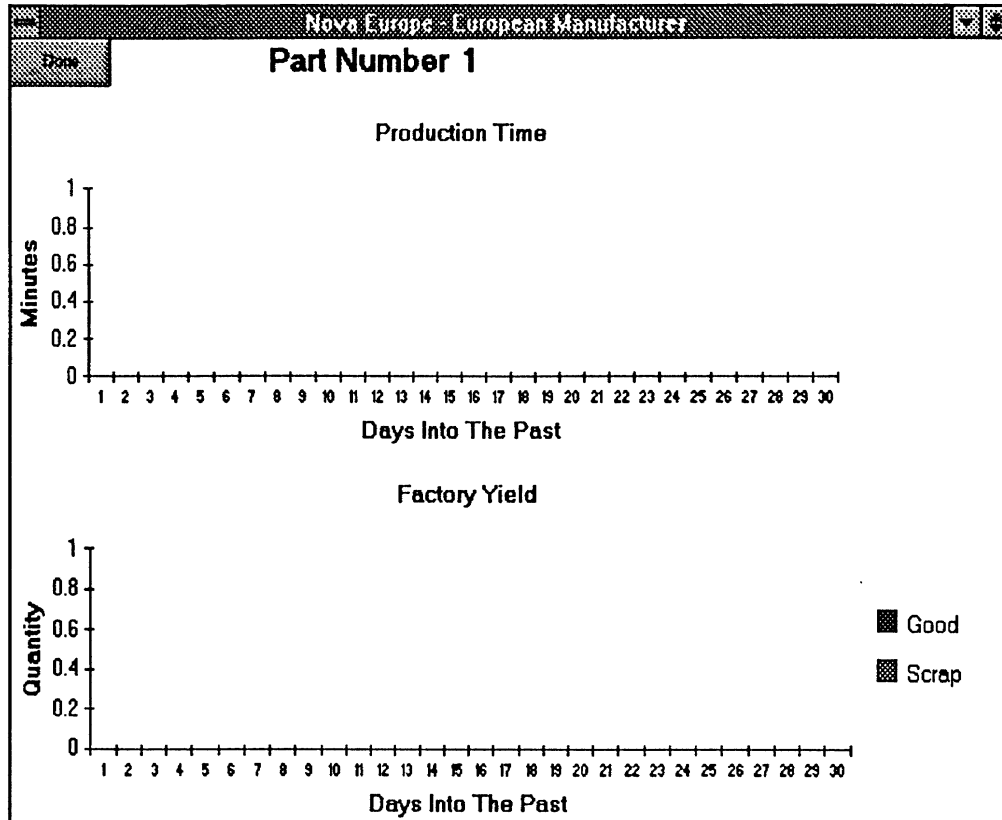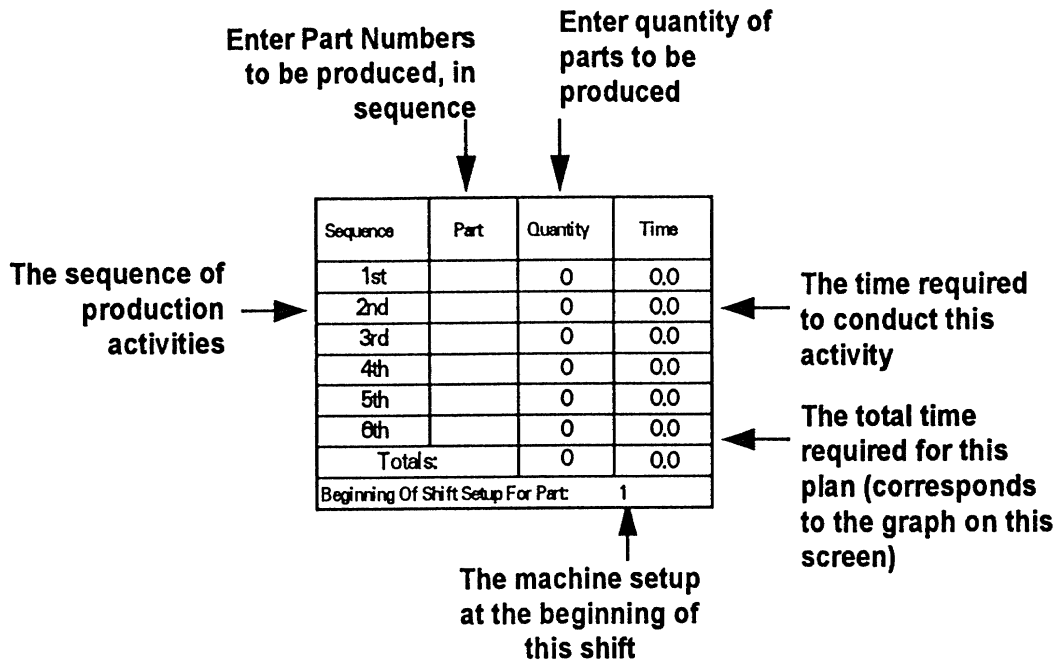

Since this is the first day of play, these values are zero.

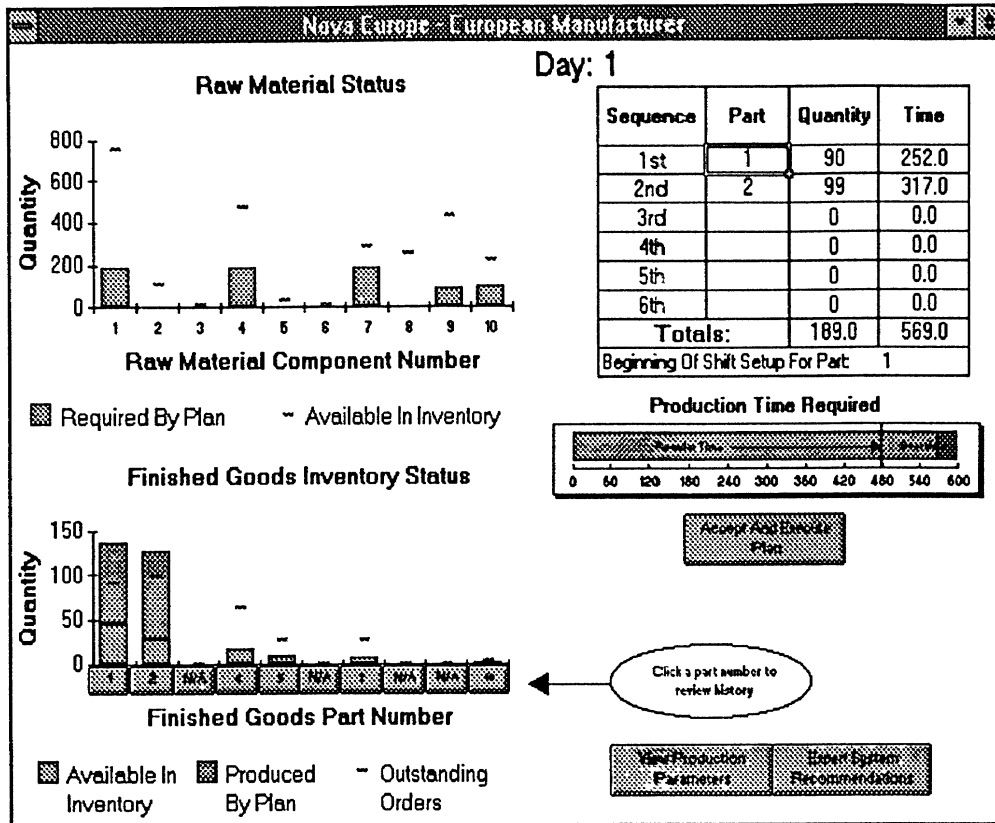Now click the "Done" button to return to the Production Planning Screen.

Next, you will enter the production plan for Day 1. The Production Plan grid looks like this:

Entering A Production Plan

Enter Part Numbers to be produced, in sequence ↓

Enter quantity of parts to be produced ↓

The sequence of production activities →

Sequence	Part	Quantity	Time
1st		0	0.0
2nd		0	0.0
3rd		0	0.0
4th		0	0.0
5th		0	0.0
6th		0	0.0
Totals:		0	0.0
Beginning Of Shift Setup For Part:		1	

← **The time required to conduct this activity**

← **The total time required for this plan (corresponds to the graph on this screen)**

↑ **The machine setup at the beginning of this shift**

In the column labeled "Part", you specify which of Parts 1, 2, 4, 5, 7 and 10 you wish to produce in the sequence indicated by the "Sequence" column. In the column labeled "Quantity", you enter the number of these parts to produce. Notice at the bottom of the grid the line containing "Beginning Of Shift Setup For Part: 1". This tells you that the last part produced yesterday was Part 1. If it makes sense to produce Part 1's today, you may wish to start with these to avoid a setup.

Enter the numbers in the above illustration, and watch the information in the charts change to reflect this plan as each number is added. When you're finished, your screen should look like this:

Nova Europe - European Manufacturer

Day: 1

Raw Material Status

Raw Material Component Number

Quantity (y-axis): 0, 200, 400, 600, 800

Raw Material Component Number (x-axis): 1 2 3 4 5 6 7 8 9 10

▨ Required By Plan   ▀ Available In Inventory

Sequence	Part	Quantity	Time
1st	1	90	252.0
2nd	2	99	317.0
3rd		0	0.0
4th		0	0.0
5th		0	0.0
6th		0	0.0
Totals:		189.0	569.0

Beginning Of Shift Setup For Part   1

Production Time Required

0 60 120 180 240 300 360 420 480 540 600

Accept And Execute Plan

Finished Goods Inventory Status

Quantity (y-axis): 0, 50, 100, 150

Finished Goods Part Number

▨ Available In Inventory   ▨ Produced By Plan   ▀ Outstanding Orders

Click a part number to review history

New Production Parameters   Expert System Recommendations

Notice that our plan requires 569 minutes to produce the 189 parts, and that we will have produced enough of Parts 1 and 2 to meet the outstanding demand. This assumes, of course, that things go according to plan - in particular, it assumes that there are no machine breakdowns, no scrapped parts, and that average run times and setup times are obtained. As you will soon see, these can be dangerous assumptions.

Next, click the button called "Expert System Recommendations". The values that we previously entered manually are entered automatically. The Expert System for the Production Planning activity provides you with a set of recommendations based on the following algorithm:

- each part is scheduled in turn, beginning with the part for which the production facility is set up at the beginning of the shift
- for each part, the quantity to produce is established by attempting to schedule enough to increase inventory to meet present demand plus provide one day of safety stock
- if there is insufficient raw material to produce this amount, then an amount is scheduled up to the level which raw material will permit
- if time is insufficient (including overtime), then an amount is scheduled which will consume all remaining time

The Expert System can be used to provide a first approximation, or to produce a reasonably sensible plan quickly when time is short.

Now click the "Accept And Execute Plan" button to begin the production run. The following screen will appear next:

Day 1

Production Report

Finished Goods Product Number

	1	2	#N/A	4	5	#N/A	7	#N/A	#N/A	10	Totals
Number Of Units Planned For Production	90	99		0	0		0			0	189
Number Of Units Started Production	90	99		0	0		0			0	189
Number Of Units Scrapped	3	3		0	0		0			0	6
Number Of Units Completed In Time For Todays Shipment	71	0		0	0		0			0	71
Number Of Units Not Completed In Time For Todays Shipment	16	96		0	0		0			0	112
Total Output	87	96		0	0		0			0	183
Number Of Minutes Factory In Operation	252	317		0	0		0			0	569

This screen reports the outcome of the day's production run. In the case of Part 1, for example, you planned to produce 90 units of Part 1, so 90 were started. Three were scrapped during production, however, so that total output was only 87. Of these, 71 were produced in time for shipment today (shipments are finalized at noon each day), and the remaining 16 were added to Finished Goods inventory for shipment tomorrow. In total, Part 1 activities consumed 252 minutes of Factory operation. Notice that 569 minutes were consumed in total, which agrees with your plan. Beware that this will not always be the case - frequently, there will be less than 600 minutes of productive capacity in the factory due to machine failure and fluctuations in setup and run times.

Click the "Done" button to return to the Main Menu, then click the "Factory Daily Cost Report" button located just to the right of the Production activity button. The following screen appears:

Day: 1

Daily Factory Cost Report

Cost Data

Standard Production Costs		
Material		53,710.08
Labor	Regular	12,662.00
	Overtime	3,520.84
Overhead		7,503.91
Total Cost		77,396.83

This report provides a breakdown of operating costs incurred during production.

Shipping

Central Warehouse Performance Report — Shipping — Central Warehouse Inventory And Shipping Report

Click the "Shipping" activity button - the following screen appears:

Your shipping decisions are made part by part - you select the next part to ship by clicking its number in the dialog box on the right of the screen. To select the first part, for example, click in the small circle to the left of the words "Product # 1". The dialog box should then look like this:

Now click the "OK" button at the bottom of the dialog box - the Shipping Screen will appear:

The Shipping Screen

The table in the upper right-hand corner of the screen provides information about outstanding orders. The columns contain the following information, beginning at the left:

- The DC whose order is outstanding (if any)
- Whether the order is "regular" or "expedite"
- The number of units of this part that have been requested
- The number of units of this part that you intend to ship to this DC today - on your screen, this column will be light blue, signifying a data-entry area
- The present transfer price, denominated in your local currency (i.e.: Deutschemarks). Notice that your Transfer Price to all regions is the same - you have no financial incentive, therefore, to favor one DC over another.

- The fill rate that you have achieved to date for this part with this DC for this type of shipment - #N/A means that the fill rate is not applicable, since there have been no orders yet of the indicated type.
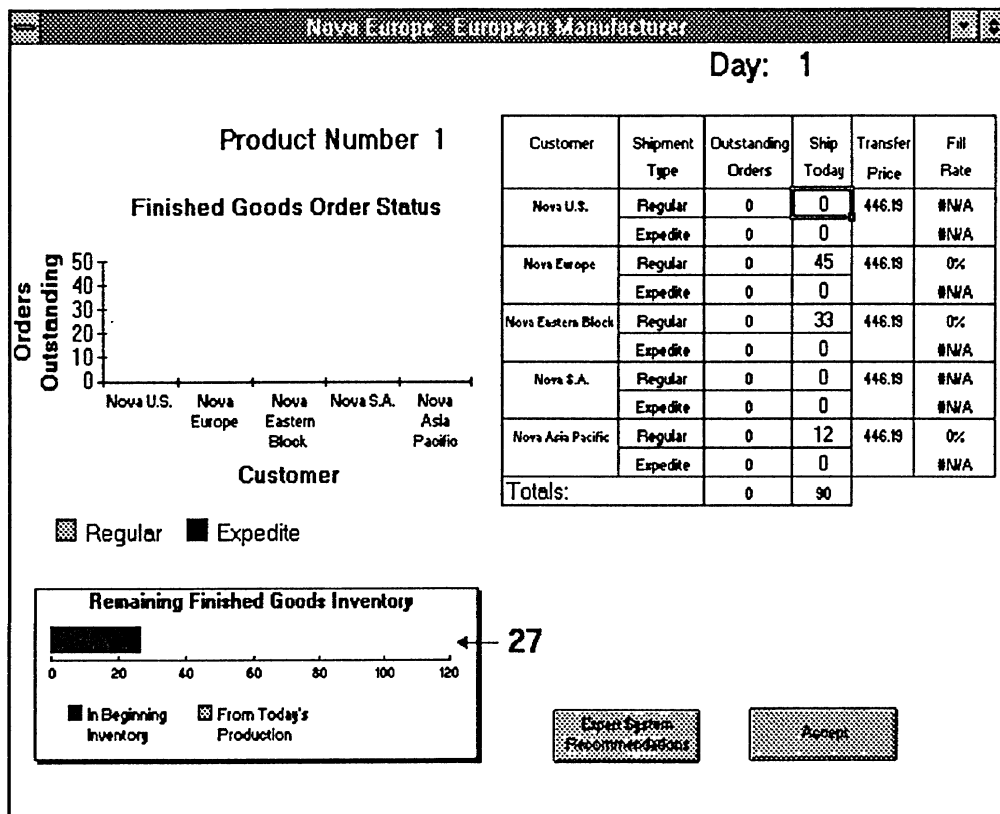
The chart on the right illustrates outstanding orders (the same information that is available in the third column of the table). As you enter your shipment decisions in the table, these columns will change to reflect the shipment.

The chart in the lower left-hand portion of the screen shows your present inventory of this part - both the amount on hand at the beginning of the day and the amount produced in time for shipment today are shown.

As with Production, there is an Expert System button for shipping. If you click this box, the Expert System will fill in the table for you, as follows:

- proceeding from the top of the table downward, the algorithm looks first for outstanding Expedite orders. If it finds any, they are satisfied (provided that sufficient inventory exists).
- if inventory remains after satisfying the outstanding Expedite orders, the algorithm returns to the top of the table and looks for outstanding Regular orders to satisfy

Now satisfy all of the outstanding orders by entering values in the appropriate cells, as shown below, and watch the charts change to reflect your entry. The screen should look like this when you're finished:

Day: 1

Product Number 1

Finished Goods Order Status

Customer	Shipment Type	Outstanding Orders	Ship Today	Transfer Price	Fill Rate
Nova U.S.	Regular	0	0	446.19	#N/A
	Expedite	0	0		#N/A
Nova Europe	Regular	0	45	446.19	0%
	Expedite	0	0		#N/A
Nova Eastern Block	Regular	0	33	446.19	0%
	Expedite	0	0		#N/A
Nova S.A.	Regular	0	0	446.19	#N/A
	Expedite	0	0		#N/A
Nova Asia Pacific	Regular	0	12	446.19	0%
	Expedite	0	0		#N/A
Totals:		0	90		

Remaining Finished Goods Inventory ← 27

Since you have shipped a total of 90 parts, the original inventory of 117 is now 27, and there are no outstanding orders.

Click the "Accept" button to execute this shipping plan for this part. The Part Selection dialog box re-appears - notice that it has changed slightly. Part # 1 has moved into the box labeled "Done" to help you remember that you have already processed this part. If you wish, you can select a part in the "Done" box again to revise an earlier decision - this is strictly a memory aid.

Now click the button in the dialog box labeled "Expert System". When you do so, the remaining parts (i.e.: the ones in the "To Do" box) are processed in turn by the Expert System, and you are returned to the Main Menu.

The two report buttons beside the Shipping button summarize the operating and financial results of the Shipping activity.

Click the button labeled "Central Warehouse Performance Report" to obtain the following report:

Nova Europe - European Manufacturer										
Central Warehouse Performance Report									Day: 1	

Customer Delivery Data   Product Number

	1	2	#N/A	4	5	#N/A	7	#N/A	#N/A	10
Back Orders At End Of Day	0	71		46	17		20			2
Today's Fill Rate	100%	28%		27%	37%		26%			33%
Average Fill Rate Through Today	100%	28%		27%	37%		26%			33%

Cost Data

Picking/Packing Cost	
Regular Shipments	80.00
Expedited Shipments	160.00
Finished Goods Holding Cost	214.00
Fixed Operating and Overhead	2,424.00
Total Cost	2,878.00

This report summarizes back orders and fill rates, and provides a breakdown of costs (in Deutschemarks) of shipping costs.

Click the "Done" button to return to the Main Menu, then click the button labeled "Central Warehouse Inventory And Shipping Report" to obtain the following report:

Day: 1

Central Warehouse Inventory And Shipping Report

Note: "Outstanding Orders" include today's orders but exclude today's shipments.

Product Number

		1	2	#N/A	4	5	#N/A	7	#N/A	#N/A	10
Beginning On-Hand Inventory		46	28		17	10		7			1
Received From Manufacturing Available For Shipment Today		71	0		0	0		0			0
Customer Nova U.S.	Outstanding Orders (regular)	0	0		0	0		0			0
	(expedite)	0	0		27	6		3			0
	Today's Shipments (regular)	0	0		0	0		0			0
	(expedite)	0	0		17	6		3			0
Customer Nova Europe	Outstanding Orders (regular)	45	63		0	0		0			0
	(expedite)	0	0		12	9		3			0
	Today's Shipments (regular)	45	28		0	0		0			0
	(expedite)	0	0		0	4		3			0
Customer Nova Eastern Block	Outstanding Orders (regular)	33	27		0	0		0			0
	(expedite)	0	0		12	6		3			0
	Today's Shipments (regular)	33	0		0	0		0			0
	(expedite)	0	0		0	0		1			0
Customer Nova S.A.	Outstanding Orders (regular)	0	0		0	0		0			0
	(expedite)	0	0		9	3		6			0
	Today's Shipments (regular)	0	0		0	0		0			0
	(expedite)	0	0		0	0		0			0
Customer Nova Asia Pacific	Outstanding Orders (regular)	12	9		0	0		0			0
	(expedite)	0	0		3	3		12			3
	Today's Shipments (regular)	12	0		0	0		0			0
	(expedite)	0	0		0	0		0			1
Total Shipped Today		90	28		17	10		7			1
End Of Day Receipt Of Production		16	96		0	0		0			0
Cumulative Demand Through Today		90	99		63	27		27			3
Cumulative Shipped Through Today		90	28		17	10		7			1

This report provides more detail on the status of outstanding orders, and shows the cumulative counts of orders received and parts shipped since the beginning of play.

Click the "Done" button to return to the Main Menu. The Shipping activity is now complete.

Up until this point in the day, you have been concerned primarily with decisions about finished goods - who wants then (Order Entry), how many should be manufactured (Production) and where they should be sent (Shipping). Your focus now shifts to raw materials. The Receiving activity accepts incoming shipments of raw material components from your suppliers that have been sent in response to orders you have placed on previous days. The Procurement activity places today's raw material component orders.

Receiving

Click the "Receiving" activity button to receive today's shipments of raw material from your suppliers. Since there are no decisions to make here, you remain on the Main Menu after clicking this button. Now click the "Raw Material Inventory Report" button beside the Receiving button and obtain the following statement of components received and resulting inventory status for the ten raw material components:

Raw Material Inventory Report Day: 1

|	Component Number									
	1	2	3	4	5	6	7	8	9	10
Beginning Inventory	756	104	10	476	39	8	290	254	433	220
Production Requirements	189	0	0	189	0	0	189	0	90	99
Received From										
Acme	0	0	0	0	0	0	0	0	0	0
Lyon	0	0	0	0	0	0	0	0	0	0
Polski	0	0	0	0	0	0	0	0	0	0
Bianca	0	0	0	0	0	0	0	0	0	0
Sumi	0	0	0	0	0	0	0	0	0	0
Total Receipts	0	0	0	0	0	0	0	0	0	0
Ending Inventory	567	104	10	287	39	8	101	254	343	121

Since this is the first day of play, no previous orders have been placed and so no incoming shipments of raw material were received today.

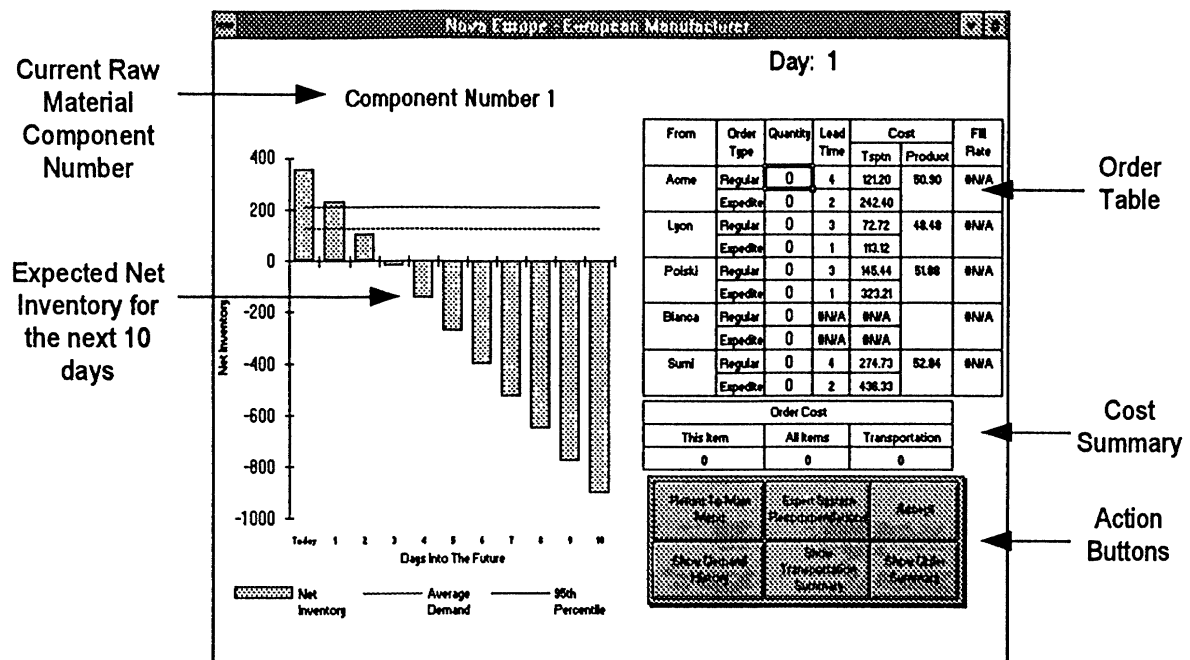Click the "Done" button to return to the Main Menu.

Procurement
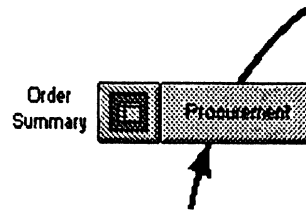
Click the "Procurement" activity button to begin the process of ordering raw material components from your suppliers. The following screen appears:
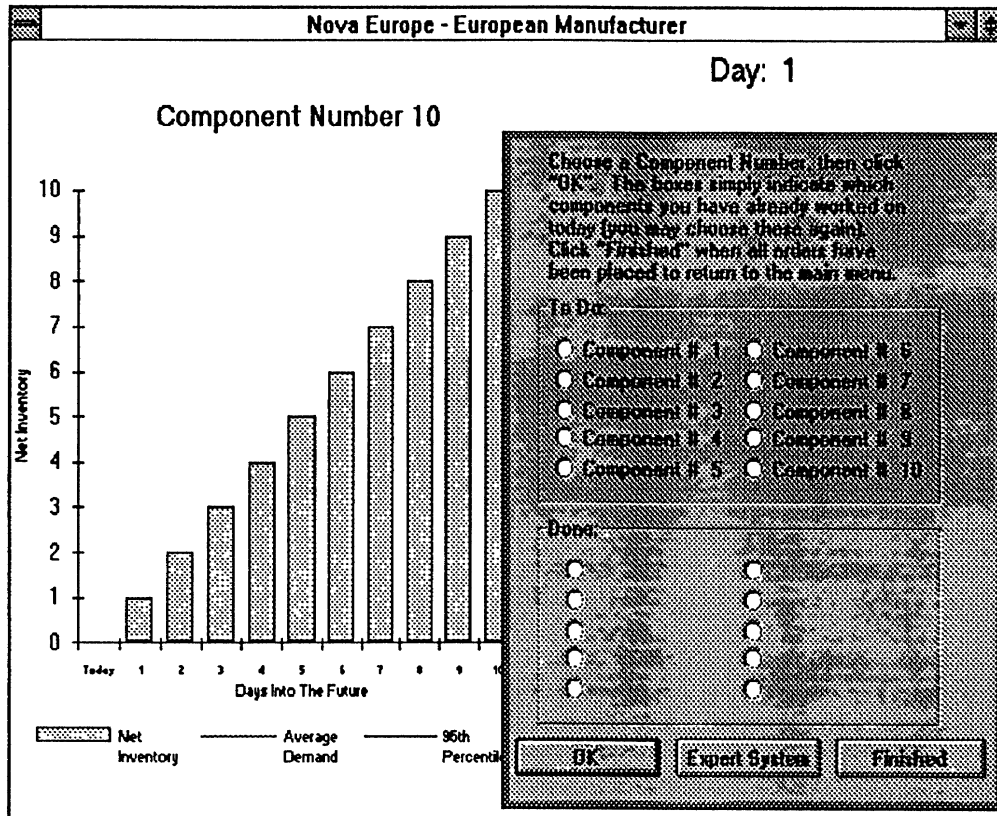
You will order your raw material component-by-component - click in the circle beside Component # 1, then click the "OK" button at the bottom of the gray dialog box. The following screen appears:

The Procurement Screen

Labels on figure: Current Raw Material Component Number; Expected Net Inventory for the next 10 days; Order Table; Cost Summary; Action Buttons; Component Number 1; Day: 1

From	Order Type	Quantity	Lead Time	Cost Tsptn	Product	Fill Rate
Acme	Regular	0	4	121.20	80.90	#N/A
	Expedite	0	2	242.40		
Lyon	Regular	0	3	72.72	48.48	#N/A
	Expedite	0	1	113.12		
Polski	Regular	0	3	145.44	51.88	#N/A
	Expedite	0	1	323.21		
Bianca	Regular	0	#N/A	#N/A		#N/A
	Expedite	0	#N/A	#N/A		
Sumi	Regular	0	4	274.73	52.84	#N/A
	Expedite	0	2	436.33		

Order Cost		
This Item	All Items	Transportation
0	0	0

Your orders will be entered in the third column of the Order Table (on your screen, this column is light blue, signifying a data entry area). Before describing this table, however, let's look at some of the other information and actions available on this screen.

The chart on the right shows "Expected Net Inventory" in the future. This value is computed as follows:

- Today's value is the number of components of this type presently in inventory (after the production draw-down and the receipt of today's shipments) *minus the amount of this component necessary to manufacture all outstanding finished goods orders.* Using the Bill Of Materials, the system goes through all outstanding finished goods orders and computes the number of units of this raw material component necessary to fulfill these orders. Consequently, if there is an order backlog which requires more of this component than is presently in stock, today's Expected Net Inventory can be negative, signaling that inventories of this component should be replenished immediately.

- Values for future days are computed by
    - adding to the previous day's inventory the number of units expected from suppliers on that day as a result of orders placed with them, and
    - subtracting from this result the average daily demand for this component type.

The present chart tells you, for example, that there is enough of Component # 1 in inventory to meet all orders that are outstanding today (since today's value is positive),

and that if demand during the next few days is average, you will have enough of these components to meet two days of demand (since these values are also positive). You will, however, experience a shortage three days into the future.

The Cost Summary table provides a running total of the purchase and transportation costs of both this component, and all components ordered so far today. These values are presently zero because no components have yet been ordered.

Below the Cost Summary table are six buttons. These perform the following actions:

- The "Return To Main Menu" button terminates the order process and returns to the Main Menu. Recall, however, that the Procurement activity can be invoked as often as you wish. Therefore, if you want to return to the Main Menu to review other information (say raw material receipts for today), you can click this button, work with the Main Menu, and then return to the Procurement activity by clicking the Procurement button again.

- The "Expert System Recommendations" button provides a reasonably good estimate of component needs - the specific algorithm will be described later.

- The "Accept" button must be clicked when the order plan that you have entered in the Order Table is acceptable and you wish to accept it and move on to the next component.

- The "Show Demand History" button produces a chart showing demand for this component for the last ten days. Click this button now to see the following report, then click the "Done" button to return to the Procurement screen.
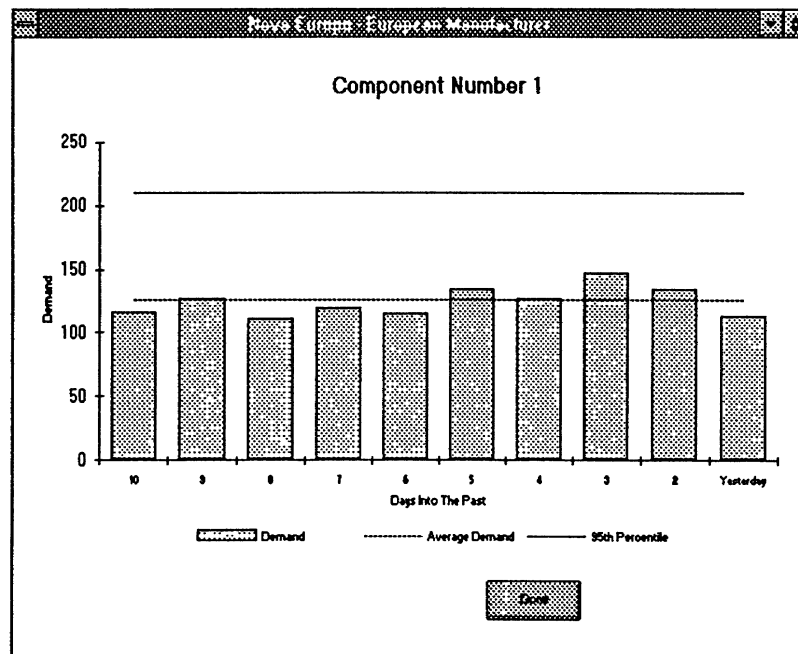
- The "Show Transportation Summary" button provides a consolidated statement of transportation costs for *all* of today's component orders. Click this button now, and examine the report that results:

Transportation Cost Summary		Acme		Lyon		Polski		Bianca		Sumi	
Day: 1		Regular	Expedite	Regular	Expedite	Regular	Expedite	Regular	Expedite	Regular	Expedite
Component Number	1	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0
Total Components Ordered Today		0	0	0	0	0	0	0	0	0	0
Components Per Box		25	25	25	25	25	25	25	25	25	25
Number of Boxes		0	0	0	0	0	0	0	0	0	0
Transportation Cost Per Box		121	242	73	113	145	323	242	339	275	438
Transportation Cost		0	0	0	0	0	0	0	0	0	0
Available Space In Last Box		0	0	0	0	0	0	0	0	0	0
Number Of Component Types		0									
Handling Cost Per Component Type		40									
Total Handling Cost		0									

Total Transportation And Handling Cost: 0

Across the top are the five raw material component suppliers:

- ACME is located in the US
- Lyon is located in Europe
- Polski is located in the Eastern Bloc
- Bianca is located in South America
- Sumi is located in the Asia Pacific region

The top part of the table identifies the number of components ordered from each of these suppliers so far today - notice that you can request either "Regular" or "Expedited" service (more on this later). The bottom part of the table summarizes your order costs so far:

- note the "Components Per Box" row - your suppliers pack your orders into boxes of a certain size (in the present case, all use a box-size of 25), and *your inbound transportation costs depend on the number of boxes you receive*, not the number of components in the box. The "per-box" and total transportation costs are shown (in Deutschemarks), and you are also told the number of empty spaces in the last box. This

assumes that only today's orders will be sent in these boxes - this may not be the case if the supplier ships back-orders on the same day.

- at the bottom of the table, your handling costs are shown - these costs are a function of the number of *different* component types that you will handle in the incoming shipment of these goods

Click the "Done" button now to return to the Procurement Screen.

- The "Show Order Summary" button produces a brief summary of orders placed, which will be described later.

Now let's examine the Order Table in detail. The **first** column identifies the supplier, and the **second** column identifies the type of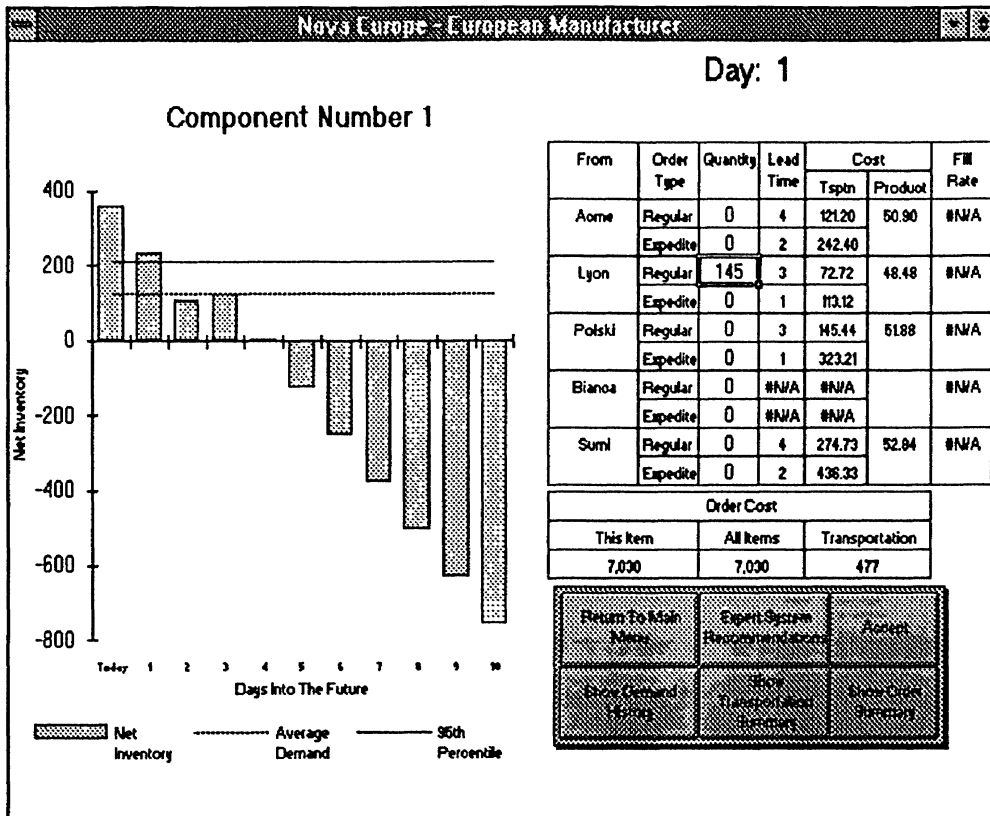 order that you wish to place with that supplier. Regular orders will be sent using a cheaper transportation mode, but will take longer, as detailed in the **fourth** and **fifth** columns (an "#N/A" in these columns indicates that the supplier does not supply the part). Recall that transportation costs are in Deutschemarks per box. Lead time is an estimate - while your inbound transportation carrier is reasonably reliable, there are still fluctuations in this time. In general, there is a 90% chance that the shipment will arrive in the indicated time. The **third** column is where you enter your orders. The **sixth** column is the component's cost from that supplier - this cost is in Deutschemarks, and will increase with inflation in the supplier's country and with fluctuations in the foreign exchange rates. The **seventh** column is the fill rate that you have obtained from each supplier so far for this component.

| From	Order Type	Quantity	Lead Time	Cost		Fill Rate
				Tsptn	Product	
Acme	Regular	0	4	121.20	50.90	#N/A
	Expedite	0	2	242.40		
Lyon	Regular	0	3	72.72	48.48	#N/A
	Expedite	0	1	113.12		
Polski	Regular	0	3	145.44	51.88	#N/A
	Expedite	0	1	323.21		
Bianca	Regular	0	#N/A	#N/A		#N/A
	Expedite	0	#N/A	#N/A		
Sumi	Regular	0	4	274.73	52.84	#N/A
	Expedite	0	2	436.33		

Request 145 units of Component # 1 from Lyon as a "Regular" shipment by keying the number into the appropriate cell and pressing the "Enter" key on the keyboard. Your screen should look like this:

Nova Europe - European Manufacturer

Day: 1

Component Number 1

From	Order Type	Quantity	Lead Time	Cost		Fill Rate
				Tsptn	Product	
Acme	Regular	0	4	121.20	50.90	#N/A
	Expedite	0	2	242.40		
Lyon	Regular	145	3	72.72	48.48	#N/A
	Expedite	0	1	113.12		
Polski	Regular	0	3	145.44	51.88	#N/A
	Expedite	0	1	323.21		
Bianca	Regular	0	#N/A	#N/A		#N/A
	Expedite	0	#N/A	#N/A		
Sumi	Regular	0	4	274.73	52.94	#N/A
	Expedite	0	2	436.33		

Order Cost

This Item	All Items	Transportation
7,030	7,030	477

Notice that "Expected Net Inventory" three days into the future increases, since lead-time from Lyon for regular orders is three days. If you want to see this again, enter 0 in the same cell to return to the original "no-order" situation, then re-enter 145.
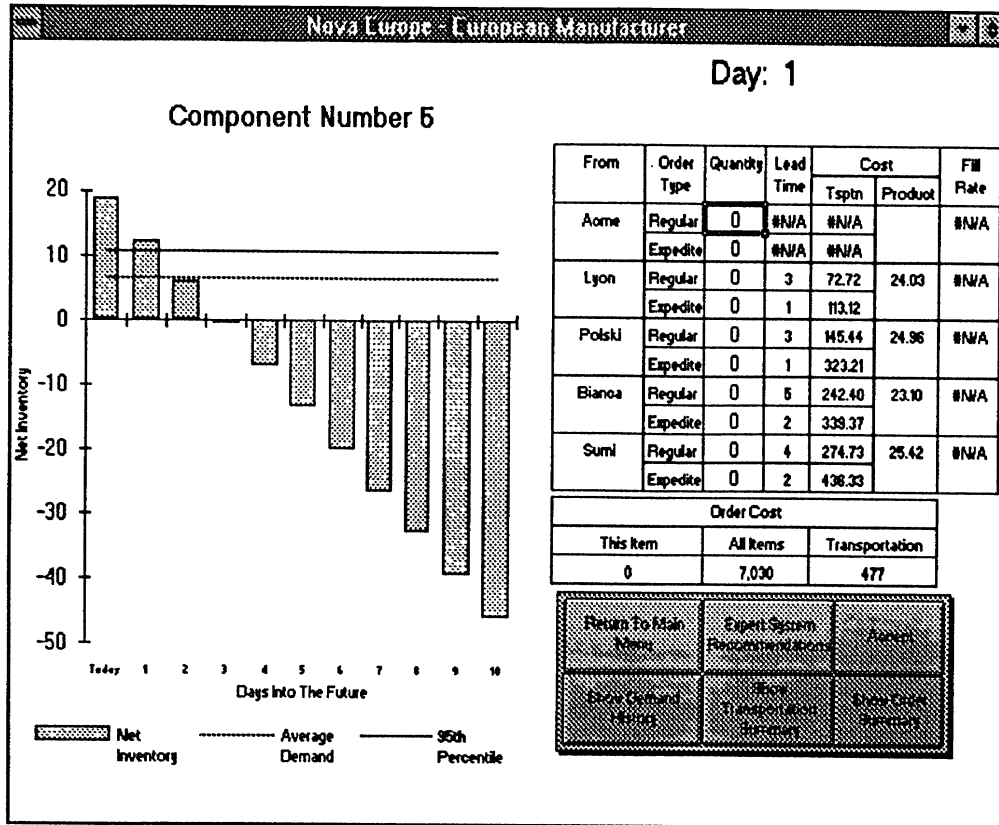
So far, no order has actually been placed - the charts and tables have been updated to show you the expected outcome of the order, but you must click the "Accept" button to actually place the order.

Click the "Accept" button now to place the order and obtain the following screen:
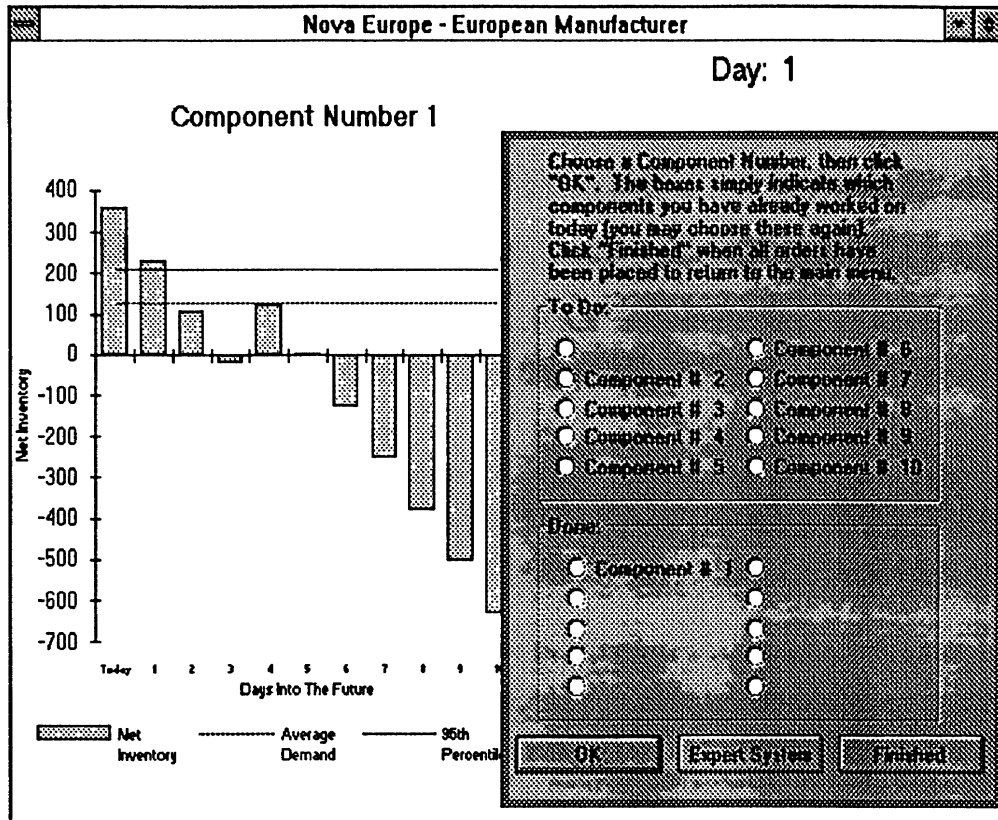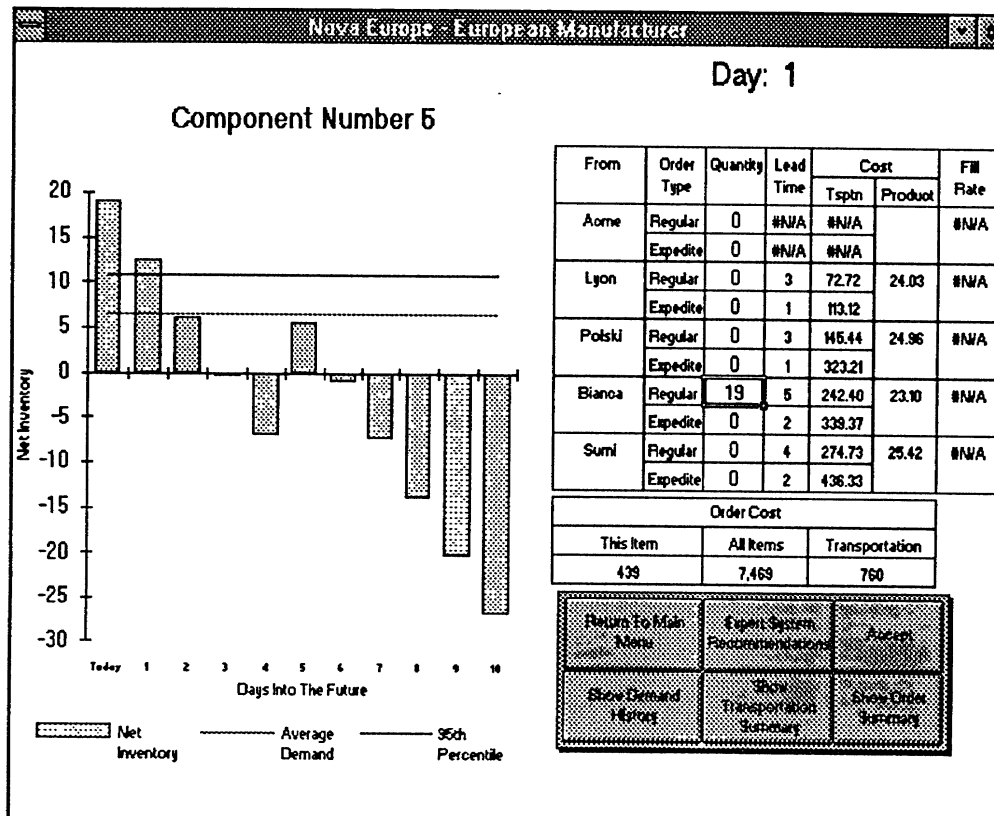
Notice that Component # 1 is now in the "Done" portion of the dialog box. You can select Component # 1 again later if you wish, or you can click "Finished" to return to the Main Menu, but instead you'll order another component.

Click the circle beside "Component # 5" and then click the "OK" button at the bottom of the dialog box. The following screen appears:

Nova Europe - European Manufacturer

Day: 1

Component Number 5

From	Order Type	Quantity	Lead Time	Cost		Fill Rate
				Tsptn	Product	
Aome	Regular	0	#N/A	#N/A		#N/A
	Expedite	0	#N/A	#N/A		
Lyon	Regular	0	3	72.72	24.03	#N/A
	Expedite	0	1	113.12		
Polski	Regular	0	3	145.44	24.96	#N/A
	Expedite	0	1	323.21		
Bianoa	Regular	0	5	242.40	23.10	#N/A
	Expedite	0	2	339.37		
Sumi	Regular	0	4	274.73	25.42	#N/A
	Expedite	0	2	436.33		

Order Cost		
This Item	All Items	Transportation
0	7,030	477

Click the "Expert System Recommendations" button.

The Expert System provides the following recommendation:

Nova Europe - European Manufacturer

Day: 1

Component Number 5

From	Order Type	Quantity	Lead Time	Cost		Fill Rate
				Tsptn	Product	
Aome	Regular	0	#N/A	#N/A		#N/A
	Expedite	0	#N/A	#N/A		
Lyon	Regular	0	3	72.72	24.03	#N/A
	Expedite	0	1	113.12		
Polski	Regular	0	3	145.44	24.96	#N/A
	Expedite	0	1	323.21		
Bianoa	Regular	19	5	242.40	23.10	#N/A
	Expedite	0	2	339.37		
Sumi	Regular	0	4	274.73	25.42	#N/A
	Expedite	0	2	436.33		

| Order Cost		
This Item	All Items	Transportation
439	7,469	760

25

It recommends that we order 19 Components from Bianca as a regular shipment. To arrive at this recommendation, the algorithm proceeds as follows:

- the low-cost supplier is found (product only - transportation is not considered)

- if Expected Net Inventory is positive on the day that this supplier can deliver a **regular** shipment, no order is placed

- if Expected Net Inventory is negative on the day that this supplier can deliver a **regular** shipment, then an order is placed - the quantity is determined by computing the number of components necessary to increase Expected Net Inventory on the delivery day to one day of safety stock

- expedited shipments are not considered

Since Expected Net Inventory is used in the above algorithm, all past orders are taken into account, and average demand is assumed (see the explanation of Expected Net Inventory above if you're not clear on this).

In the present case, notice that the Expected Net Inventory five days from now is just below the line indicating Average Demand - that is, one day's safety stock will be available on Day 6 if the order arrives on time. The bar is just below the average line because the algorithm rounds down to the nearest integer value.

Click the "Accept" button to place this order and obtain the following screen:
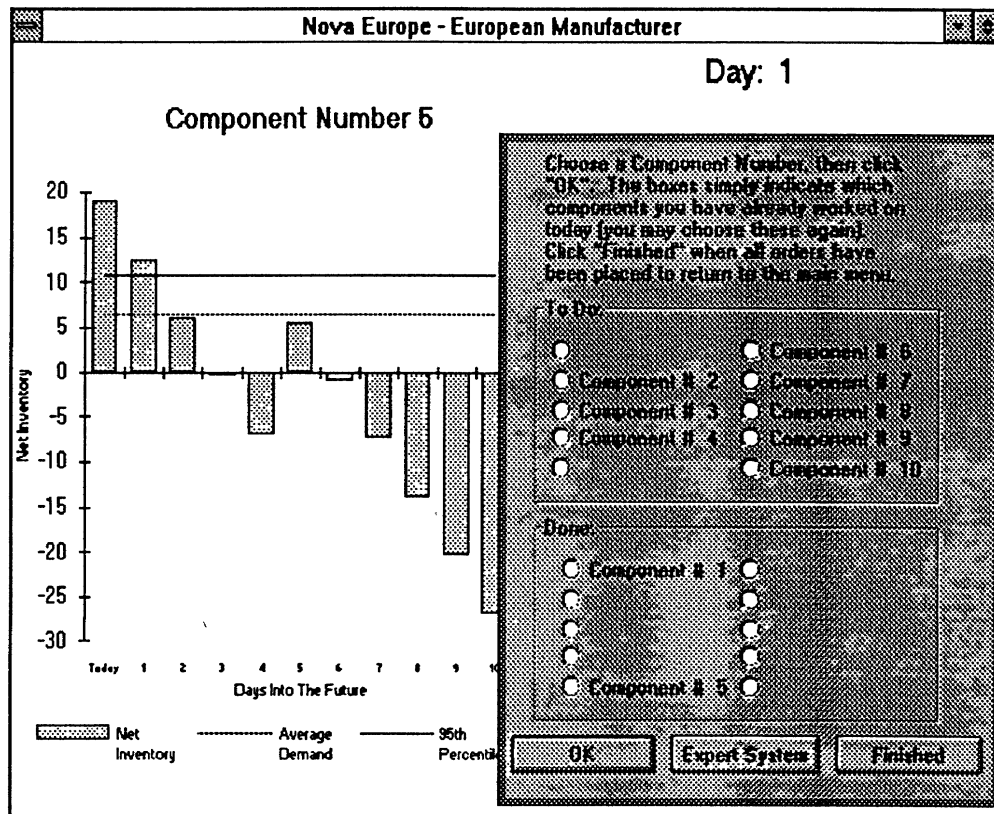
You could proceed component-by-component, as you have been doing, but instead you'll ask the Expert System to finish the components not yet processed. When you click the "Expert System" button on the dialog box, all remaining components are ordered using the Expert System. When you click the Expert System button on the Procurement Screen for a particular component, the Expert System merely provides a recommendation for that component that you can either "Accept" or modify as you see fit.

Click the "Expert System" button in the dialog box to complete all orders for components not yet processed and return you to the Main Menu (note that your decisions about components already processed will not be changed - only components in the "To Do" portion of the dialog box will be processed automatically).

Finally, click the Order Summary button beside the "Procurement" activity button to view a summary of your ordering activity for the day:

Nova Europe - European Manufacturer

Day: 1

Supplier

Order Summary / Component Number	Acme Quantity	Acme Price	Lyon Quantity	Lyon Price	Polski Quantity	Polski Price	Bianca Quantity	Bianca Price	Sumi Quantity	Sumi Price	Totals
1	0	51	145	48	0	52			0	53	7,030
2	19	63							0	66	1,197
3	0	84			4	82			0	87	330
4			0	18	0	19	606	18	0	20	10,772
5			0	24	0	25	19	23	0	25	439
6			0	31	0	33	1	30	0	33	30
7			260	6	0	7			0	7	1,680
8					146	8			0	9	1,228
9							53	8	0	9	1,237
10							0	9	0	10	0
Totals	19		405		150		779		0		23,942

Click the "Done" button to return to the Main Menu. The Procurement activity is now complete for today.

Viewing Financial Results

Click the "Overall Financial Results" button on the Main Menu to review today's financial results:

Income Statement	(In Deutschmarks)		Day: 1
Sales Revenue			88,753
Cost Of Goods Sold			
Finished Goods Inventory Value (Day 1)		45,100	
Add Cost Of Goods Manufactured			
Raw Material Inventory Value (Day 1)	86,957		
Raw Material Purchases	0		
Raw Material Handling Costs	0		
Transportation Costs (Inbound)	0		
Cost Of Materials Available For Use	86,957		
Deduct Current Raw Materials Inventory Value	65,273		
Cost Of Materials Used		21,684	
Direct Labor		6,196	
Manufacturing Overhead		2,873	
Total Cost Of Goods Manufactured		30,754	
Cost Of Finished Goods Available For Sale		75,854	
Deduct Current Finished Goods Inventory Value		31,293	
Cost Of Goods Sold			44,561
Gross Margin On Sales			44,192
Operating Expenses			
Selling			
Picking And Packing		240	
Central Warehouse Fixed Overhead		2,424	
Total Selling Expenses		2,664	
General And Administrative			
Administrative Overhead		2,586	
Raw Material Inventory Holding Costs		715	
Finished Goods Inventory Holding Costs		214	
Total G&A Expenses		3,515	
Total Operating Expenses			6,179
Net Income Before Income Taxes			38,013
Income Tax Expense			15,585
Net Income After Income Taxes			22,428

You have earned 22,428 Deutschemarks since the beginning of play (i.e.: today). Take some time to study this statement - it contains valuable information about your costs.

Now click the "US Dollars" button to view the same results in US currency:

Income Statement (In US Dollars) Day: 1

Sales Revenue				54,920
Cost Of Goods Sold				
Finished Goods Inventory Value (Day 1)			27,908	
Add Cost Of Goods Manufactured				
Raw Material Inventory Value (Day 1)	53,809			
Raw Material Purchases	0			
Raw Material Handling Costs	0			
Transportation Costs (Inbound)	0			
Cost Of Materials Available For Use	53,809			
Deduct Current Raw Materials Inventory Value	40,391			
Cost Of Materials Used		13,418		
Direct Labor		3,834		
Manufacturing Overhead		1,778		
Total Cost Of Goods Manufactured			19,030	
Cost Of Finished Goods Available For Sale			46,938	
Deduct Current Finished Goods Inventory Value			19,364	
Cost Of Goods Sold				27,575
Gross Margin On Sales				27,346
Operating Expenses				
Selling				
Picking And Packing		149		
Central Warehouse Fixed Overhead		1,500		
Total Selling Expenses			1,648	
General And Administrative				
Administrative Overhead		1,600		
Raw Material Inventory Holding Costs		442		
Finished Goods Inventory Holding Costs		132		
Total G&A Expenses			2,175	
Total Operating Expenses				3,824
Net Income Before Income Taxes				23,522
Income Tax Expense				9,644
Net Income After Income Taxes				13,878

At today's foreign exchange rate, your cumulative net income after taxes to date is $13,878. Not a bad day's work!

Foreign Currency Considerations

Click the button labeled "Review/Change Forward Buying Decision". The following screen appears:

Nova Europe - European Manufacturer

Done

Exchange Rate Information

	Spot Rate	Forward Rate	Premium	Forward Buy?
U.S.	0.62	0.62	-0.06%	No
Europe	1.00	1.00	0.00%	No
Eastern Europe	0.93	0.93	0.08%	No
South America	0.73	0.75	3.44%	No
Asia Pacific	0.77	0.77	-0.06%	No

The **"Spot Rate"** is today's exchange rate. It is the amount of foreign currency you can purchase today for each unit of domestic currency. If you choose "No", you will buy foreign currency at the spot rate effective on the day of product delivery.

The **"Forward Rate"** is the exchange rate quoted for foreign-exchange contracts. If you choose "Yes", you will buy foreign currency at this *known* rate on the day of product delivery instead of the *unknown* spot rate on that day.

The **"Premium"** is the spread between these two rates, expressed as a percentage of the spot rate.

This screen provides an opportunity to hedge against foreign currency fluctuations with the money you must spend on raw materials abroad. You have two choices"

- Do nothing (leave the Forward Buy button on "No"), in which case you will purchase foreign currency to pay for the order at the prevailing "spot rate" on the day that the raw materials arrive - if your domestic currency performs well relative to the foreign currency in question, then you will pay less for the required amount of foreign currency on that date than expected. Conversely, however, if your currency under-performs the foreign currency, then you will pay more.

- Forward buy the foreign currency when orders are placed by clicking the "No" button for that currency (it becomes a "Yes" when you do this). When you forward buy, you enter into an agreement with a foreign exchange agent to buy the amount of currency necessary to pay for the order on the day it arrives at a rate established today - this

rate is the "Forward Rate" in the table above. This protects you against foreign exchange fluctuations, both bad and good.

The relationship between the spot rates and forward rates are determined by the financial community's outlook for changes in relative interest and inflation rates in the countries in question.

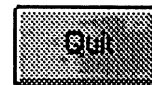Click "Done" to return to the Main Menu.

End-Of-Day
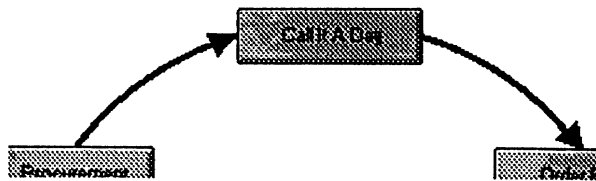
Finally, move to tomorrow by clicking the "Call It A Day" button. When you play the real version of the game with other students, there may be a delay here - all players must complete today's activities before tomorrow can begin.

Now play a few days by yourself. The results on the following page were obtained by playing the demo game for six days (the most you can play with this demo version) using the Expert System rules. Why not see if you can do better (Small Hint: the Current Finished Goods Inventory Value on Day 6 is zero - either the Expert Systems have done a *perfect* job in planning orders and production (unlikely), or something is constraining their ability to produce finished goods - what resource is likely to be constraining production on Day 6? How can you avoid the same problem?).

Exiting The Game

Finally, when you wish to exit the game, click the "Quit" button on the Main Menu.

Income Statement

[In Deutschmarks]

Day: 6

US Dollars

Sales Revenue			320,342
Cost Of Goods Sold			
Finished Goods Inventory Value (Day 1)		45,100	
Add Cost Of Goods Manufactured			
Raw Material Inventory Value (Day 1)	86,957		
Raw Material Purchases	41,741		
Raw Material Handling Costs	526		
Transportation Costs (Inbound)	16,456		
Cost Of Materials Available For Use	145,679		
Deduct Current Raw Materials Inventory Value	58,812		
Cost Of Materials Used		86,867	
Direct Labor		31,956	
Manufacturing Overhead		15,510	
Total Cost Of Goods Manufactured		134,333	
Cost Of Finished Goods Available For Sale		179,433	
Deduct Current Finished Goods Inventory Value		0	
Cost Of Goods Sold			179,433
Gross Margin On Sales			140,909
Operating Expenses			
Selling			
Picking And Packing		960	
Central Warehouse Fixed Overhead		14,559	
Total Selling Expenses		15,519	
General And Administrative			
Administrative Overhead	15,546		
Raw Material Inventory Holding Costs	5,845		
Finished Goods Inventory Holding Costs	547		
Total G&A Expenses		21,938	
Total Operating Expenses			37,457
Net Income Before Income Taxes			103,452
Income Tax Expense			42,415
Net Income After Income Taxes			61,036

NOVA INCORPORATED: CASE NOTES

a. - EXPERT SYSTEMS

b. - CURRENCY HEDGING

Working Paper

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The University of Michigan
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Expert Systems Support For Operational Decision Making

The development and deployment of _expert systems_ (ES) had been an important element of Nova's Information Systems strategy in support of the Born Again initiative. Four systems had been built to date to assist operating managers with daily decisions in procurement, production and distribution. Peter Webb, Nova's Director of Information Technology, described this undertaking as follows:

> _"We knew we couldn't completely replace human judgment_
> _in production and distribution decision-making, but we_
> _could make life easier for those folks. Ninety-nine percent_
> _of the decisions that get made are predictable and_
> _repetitive, but the calculations are tricky and people make_
> _mistakes. We felt that if we could mechanize the 99%, we_
> _could both eliminate human error and free up time to focus_
> _attention on the 1% of decisions that are really important"._

The four systems currently installed supported production scheduling and distribution at the factories, and material procurement at both the factories and the distribution centers. The decision rules for these systems are described below:

1. Production Scheduling At The Factories

The **Production Scheduling ES** determines which products to manufacture in which order and in what quantities. Production follows a cyclic schedule as below:

- Each product is considered in turn, beginning with the last product built yesterday (since factory equipment is currently set up for that product).

- For each product, the ES schedules production of an amount sufficient to satisfy all current requirements and to provide two additional days of average demand as a safety stock, (subject to availability of raw materials and production time):

> Quantity To Manufacture = today's demand + current back orders
> + safety stock - present inventory.

If this quantity is positive, the ES will attempt to schedule up to this amount. If insufficient raw materials are available, the system will schedule as much production as possible and then move on to schedule the next product. If insufficient time (including overtime) is available, the ES will schedule as much production as possible and then stop. Implicit in this and other decision rules are expectations about setup and run times for each productat each factory. The ES uses historical averages for these quantities; it makes no allowance for production scrap or machine failure.

2. Distribution At The Factories

The **Distribution ES** determines which products to ship in what quantities to each regional distribution center. For each product, the ES fills all expedited orders before reviewing any regular orders. Regions are serviced in the following sequence:

- North America
- Europe
- Eastern Bloc
- South America
- Asia Pacific.

3. Raw Material Procurement At The Factories

For each raw material component, the **Factory Procurement ES** determines which supplier to deal with, whether an order should be placed today, and how large an order to place.

- The **choice of supplier** is based on the list price of the component. The ES searches the supplier database and selects the low-price provider.

- The **decision to order** today is based upon the lead-time of the supplier selected above. The ES determines the factory's expected inventory level for the component on the day the supplier would deliver if an order *were* placed today. If the end-of-day value is greater than one day's expected demand for the component, then no order occurs; otherwise, an order is placed.

  To project future inventory levels, the ES considers present on-hand inventory, present backorders for finished goods (translated into raw material requirements through the Bill Of Materials), orders placed with suppliers but not yet received, and average daily demand. For each day in the future, the expected inventory level is calculated as follows:

  Beginning Inventory + Supplier Orders Due (or overdue) - Backorder Requirements
  - Expected Demand Over the Supplier's Lead Time

- If the ES determines that an order is required, the **quantity to order** is calculated as that amount expected to leave one day's demand as a safety stock after production on the date of delivery.

4. Finished Goods Procurement at the Distribution Centers

The **Distribution Center ES** rules are identical to the factory's in all but supplier selection. Instead of seeking out the low-price provider, the ES follows the

sourcing policies established by Nova Corporate. The North American Distribution Center, for example, will always order Product 1 from the Cincinnati factory, regardless of the (transfer) price.

Reactions to the Expert System decision rules had been mixed, and Webb found himself at the center of several heated debates over policy modification. In particular,

- Many considered the rules to be much too conservative with respect to inventory levels. On the inbound side, it was felt that one day of safety stock provided too little protection against fluctuations in demand, particularly for those products with high coefficients of variation in their demand patterns. A similar argument was made for manufacturing only two day's safety stock, with the additional complaint that the small lot sizes resulting from this policy added significantly to machine setup costs. The opposing view, however, was that a lean, high velocity logistics process was necessary in order to remain cost-competitive.

- The South American and Asia Pacific distribution centers were unhappy about the order in which the factory Distribution ES allocated products. Since they were always serviced last, they frequently were shorted and had to expedite orders in order to compete successfully for products at a factory. The other distribution centers argued that the rules were appropriate since their markets were strategically more important to Nova than either South America or Asia Pacific.

- Procurement specialists at the factories claimed that use of the list price to select raw material suppliers was too simplistic. They argued that the full delivered component cost should be used, since transportation and handling were important considerations in determining the true low-cost provider. Furthermore, they argued that transportation speed, quality levels and fill rates should also be considered in the raw material sourcing decision, since they ultimately contributed to Nova' safety stocks, scrap rates and warrantee costs.

Webb countered these criticisms by explaining that the expert systems were intended only to provide a starting point for decision making; ES users can and should override system recommendations when they were inappropriate. Webb summarized his feelings about the expert systems project:

"I think that the most important thing accomplished by the ES project was that it surfaced important issues which were previously hidden. By making operating policies explicit, we got them on the table where they could be discussed, debated and improved. We may not have all of the right rules yet, but at least we've established the right forum for debate."

Managing Performance Under Currency Fluctuation and Price Inflation

Fluctuations in inflation and currency exchange rates affect revenues and expenses at both the factories and distribution centers in a number of ways.

Effects of Inflation on Profit Center Performance

- The selling prices of Nova's products (i.e., the transfer prices at factories, and the market prices at distribution centers) are subject to inflationary changes in their source country. For example, the transfer price charged by the North American factory varies from day-to-day based on the US inflation rate, and the selling price of finished goods in South America varies according to the inflation rate in Brazil.

- The purchase price of raw materials varies according to the inflation rates in the country supplying the products. The component prices charged to Nova's factories by each of its five raw material suppliers vary according to the inflation rate of their host country. Since differing rates of inflation will change relative prices, today's low-price provider may not be tomorrow's.

- Costs incurred domestically (labor and certain overhead costs) vary with the domestic inflation rates. Labor and utility costs in Cincinnati, for example, change according to the US inflation rate.

Within any particular country, domestic costs and selling prices move together, so the balance between these values tends to be preserved. High inflation rates in Brazil, for example, increase both domestic costs and revenues so that a balance between them can avoid inflation induced performance variances. Material costs incurred out-of-county may also be kept in balance, but only indirectly through a currency hedging mechanism.

Effects of Currency Exchange Rates on Profit Center Performance

Inflation rates and foreign currency exchange rates are related in an intricate way. If inflation in country A is high relative to country B in a period, then the amount that country A will pay for country B's currency in the next period will increase, and conversely. For example, if inflation in South America is higher than inflation in the United States, then currency exchange rates will react so that South America will have to pay more Cruzeiros per US dollars in the future.

Consider the combined effect of these forces on a high-inflation-rate region such as South America. Domestic costs like labor and utilities increase directly with inflation. Off-shore costs for material also increase, due to changes in exchange rates. However, revenue improvement due to inflationary increases in domestic prices tend to offset these cost increases, so that within South America profitability tends to be preserved.

Hedging Against Undesirable Fluctuations In Currency Exchange Rates

Typically, when purchasing materials abroad, the price to be paid to the supplier in the supplier's currency is established on the day of purchase, but payment occurs only upon delivery. During the intervening period, the exchange rate for the currency involved may increase (in which case *less* domestic currency will be required on the day of payment than on the day of purchase) or decrease (in which case *more* domestic currency will be required on the day of payment than on the day of purchase). From the perspective of the buyer, the former is a good thing and the latter is a bad thing. The seller is indifferent since he will obtain the price established on the purchase day regardless of changes in currency exchange rates.

Since a forward market exists for currency, a buyer may hedge against decreases in the exchange rate by entering into an agreement with a foreign exchange broker to purchase the required foreign currency on the day of delivery at a rate established today rather than at the prevailing rate on the delivery day. Today's actual rate of exchange is called the **"Spot Rate"** and the exchange rate charged for future currency purchases is called the **"Forward Rate."** The practice of entering into foreign exchange contracts using the forward rate is called **"Forward Buying."**

Forward buying can work for and against the buyer, depending on how the spot rate on the day of delivery compares with the forward rate on the day of purchase. Suppose that the North American factory purchases raw material valued at 100,000 Yen today for delivery in 30 days. Suppose further that today's forward rate is 125 Yen/$. Then forward buying will result in a firm price of 100,000/125 = $800 to be paid to the foreign exchange broker in 30 days for the 100,000 Yen. Whether or not this is a good decision depends on the spot rate 30 days hence. If the spot rate is 120 Yen/$ on this day, for example, then $833.33 would have been required to purchase the 100,000 Yen, so the forward buying decision was a good one. If the spot rate is 130 Yen/$ on this day, however, then only $769.23 would have been required, so the forward buying decision was a bad one. Notice that the spot rate on the day of purchase did not enter into this analysis - only the forward rate on the day of purchase and the spot rate on the day of delivery are relevant.

An important question for Nova Corporate is: should profit center managers engage in forward buying. There is a strong incentive for individual factory and distribution center managers to forward buy to protect their profit projections from unanticipated swings in currency. But if each factory and distribution center engages in this practice separately, there will be many small transactions each with a transaction cost. If Corporate consolidates all forward buying, then fewer larger transactions with lower total transaction costs can result. More importantly, since Nova's subsidiaries buy and sell in overlapping markets, Corporate can maintain a dynamic structural hedge against currency fluctuation. By properly balancing corporate wide revenues and expenses, through coordinated purchasing, production and distribution decisions, potential losses (gains) by sellers can be offset by corresponding gains (losses) by buyers and the need for a currency market hedge can be avoided.