The ERP–MICSS Computerized Case Study Analysis

Developing a Winning Sales and Production Strategy

The Basic Questions and Principles

Smart Industries is a simple manufacturing environment, even though you might not feel that way after playing around with it. Trial and error might lead you to very good results, but the simulator is built upon straightforward rules that are a reasonable simplification of reality. If this is the case then a good methodology can be structured so the good results will be generated from a rational analysis. If you can come up with such basic rules for that methodology, then it should apply also to a real world Enterprise Resource Planning (ERP) implementation in spite of the huge difference in complexity.

The idea of simultaneously planning the sales and the production is a central idea being openly advocated by Dick Ling. Even though this version of the virtual environment does not contain the introduction of new products, there is a lot to plan and execute in the field of sales. The importance of looking at the sales and operation plan in integrative eyes emerges here very clearly.

Handling uncertain market demand is, of course, a dominant factor. In the virtual environment you face highly variable demand and seasonal effects that are not fully known ahead of time. The capacity at hand is certainly limited. Failing to meet the market demand might ruin the company. Hence, there is a huge risk in expanding the market demand beyond the capabilities of the production shop floor.

What can we do beyond wild guessing?

One option that used to be popular in the past is to create huge finished goods stock. You can try this option, but it is not going to work very well here, at least not when you think of really huge inventories. In the reality of manufacturing organizations, the evils of excess inventory are even more considerate than here, as it may happen that certain inventories will turn out to be dead, meaning never be sold. What can be evident in this case is the price of producing things that are not needed right now.

The approach that will be used is based on the Theory of Constraints (TOC). The main analysis does not detail how all the steps here are based on the generic TOC philosophy. Refer to Chapter 2 for more information. Instead the main analysis relates to the specifics of the case and comes up with some conclusions. Then we will try to work it out in the reality (virtual reality) of the Management Interactive Case Study Simulator (MICSS) simulation. An additional treatment of the case is to apply a more complete Drum-Buffer-Rope (DBR) planning coupled with buffer management. This addition is still based on the initial analysis but uses the capabilities of an ERP with the DBR functionality.

What Blocks the Organization from Achieving More?

The state of the organization for 1/1/02 is clear: the organization cries for **more sales**. There is no point in looking for reduction of costs. As you cannot reduce management expenses (they do not like that idea) you'll find out that reducing some inventory doesn't bring the organization into big profits. The only valid way is to **get more sales**. This surely does not surprise you. The Reference Run has shown that adding one new contract (Contract No. 3 for a package of A1 and C1) has turned out to be profitable. The problems that were revealed then were lack of materials and lack of capacity at the peak period. Once the purchasing policies were fixed, it seems that lack of capacity was minimal, causing only a small decrease in reputation.

Can We Sell Significantly More?

This question immediately leads us to think what should we sell more of? Should we accept contract 2 (for A1) even though the cost analysis claims it is losing? Should we sell more C1, more B1, and less A1 as the product cost analysis suggests?

Do these questions have anything to do with whatever the situation is in the production shop floor? There is a general tendency to first decide upon the sales planning and then attempt to find a way for production to supply it. Only in cases where there is evident lack of capacity and no simple means to add capacity that the production planning clearly states "Sorry, not possible". It seems as if the objective of Production is to satisfy the Sales requirements. Isn't it?

Well, in this particular case, there is just one way in the short-term way to add capacity: to add a whole second shift, which costs $2,523 every shift. You can add only one second shift per day. At the start of the year **there is no need to add capacity**. However, if we wish to make money we should **enhance the sales until capacity reaches its limit.** So, in a way Sales must take the challenge to sell all what the shop floor can do. Here we have a problem. There is no definite level of what the shop floor can do. It depends on the product mix. Choosing the "right" product mix can bring in much more money than another product mix that utilizes all the available capacity.

What Is the Most Profitable Product Mix, Given the Current Capacity Profile?

Once we know the answer we can look for alternatives to expand the capacity and calculate the economical value of it. The above question already recognizes the need to look at the combination of the market demand and the operational limits. It leads us to think on the relationship between the two main parameters: market potential and internal capacity.

It looks as if the answer appears in the Product Cost Analysis window (at the Finance View, Information). Every unit of product is given a margin. This determines a priority between the products. Sales should strive to give more presence to the profitable products — up to the capacity limit.

TOC challenges the traditional cost analysis. It claims that capacity limit of the whole shop floor depends on the identity of one (or very few) resource, which will be the first to turn into a bottleneck. Once a single resource is a bottleneck, the excess capacity on the other resources does not help much to produce more (unless you have products that do not need the bottleneck).

TOC argues that for an organization to function reasonably the vast majority of the resources need some minimal amount of excess capacity. Therefore, a product mix that succeeds to highly utilize most of the resources may look good on paper, but fails miserably in reality. The MICSS scenario lets you check this claim.

Assuming the TOC claim is right, it is imperative to identify the resource that will become a bottleneck first. The best product mix is one that highly utilizes that particular resource while leaving enough excess capacity on the rest of the resources.

Since there is enough validation that in the case of Smart Industries, the most likely future bottleneck is M4. Let us check a few signs:

- The "Rough Cut Capacity Planning screen, at the Production View, Information, shows the predicted overall load on the resources for the next 6 months. Here it is:

Rough Cut Capacity

Range: 6 days Months

	Quantity
A1	1140
B1	420
C1	120

	Production	Setup	Break	Total
M1	35.1%	3.9%	2.5%	41.5%
M2	42.0%	1.6%	5.0%	48.6%
M3	44.2%	2.4%	5.1%	51.7%
M4	50.8%	1.9%	7.5%	60.2%
M5	40.8%	0.0%	2.9%	43.7%
M6	45.4%	1.2%	5.2%	51.7%

The predicted load for the first half of the year on M4 is higher than the load on the other resources. It also shows M4 is currently quite far from being a bottleneck. However, if the market demand would go up keeping about the same ratio within the product mix, then M4 would be the first to become a bottleneck.

- While Rough Cut Capacity is based on predicting the future, another information screen brings us the actual utilization of the machines during the last 2 months:

Wrk-Ctr Utilization

	December				November			
	Prod.	Setup	Break	Idle	Prod.	Setup	Break	Idle
M1	35.6%	4.0%	2.5%	58.0%	51.3%	5.2%	3.2%	40.3%
M2	36.7%	1.4%	4.4%	57.6%	66.6%	1.5%	3.3%	28.6%
M3	44.7%	2.4%	5.2%	47.8%	57.9%	2.8%	2.0%	37.2%
M4	70.3%	2.7%	10.4%	16.6%	60.5%	2.6%	2.3%	34.6%
M5	68.0%	0.0%	4.8%	27.2%	30.7%	0.0%	1.7%	67.5%
M6	68.6%	1.8%	7.8%	21.8%	38.7%	0.5%	8.2%	52.6%

The Idle column is interesting. It contains how much time was wasted, due to lack of work, at the various resources. Clearly M4 had the least idle time in December. In November M2 had just a little less, but looking at both months it is clear M4 had the least idle time.

As a matter of fact we do not want M4 to become a true bottleneck. A true bottleneck, a resource that the load placed on it is equal or larger than its capacity, would cause too many orders to miss their due date. This would critically reduce the reputation of the company in the market and the market demand will go down drastically. Instead we would look to reach a stage where Sales generates a product mix that utilizes M4 to the point it is flexible enough to face the demand variability and ensures on-time shipments.

An important TOC term is throughput (T), which is similar to the notion of the added value. Throughput, according to TOC, is the rate at which the organization generates money. For a regular business company T is the revenue from sales minus the truly variable costs (TVC). That is the costs that vary directly with the number of units sold. This does not usually include direct labor. The main component of TVC is usually material. TOC is very strict in the definition of TVC. Only costs that truly change with every **unit of sale** are considered.

Setting the Sales and Production Strategy

Realizing the role of M4 in the design of strategy, let us gather some crucial information on M4 and the various products. The idea is to consider the throughput that is generated by each of the products and contracts relative to the investment in M4 capacity. We realize that all the other resources should have excess capacity — using some more capacity from the other resources does not truly generates more expenses. The real trade-off would only concern the capacity of M4.

M4 invests capacity for both process time and setup time. Some TOC practitioners ignore the setup time because any setup is an investment for a whole batch and it certainly depends on the whole batch. On the other hand, in this particular case, we have only one unit of M4 that has several different operations for each product. We decided to add the setup time for each operation, assuming a batch of 30 units. Since M4 has a 30-minute setup, on average, between any subsequent operations, the time investment of M4 for a unit of any product includes 1 minute per M4 operation in its routing. Here is the table:

Product/Contract	**T per unit**	**M4 minutes**	**T per M4 minute**
A1	$236.11	4+7+2 = 13	$18.16
B1	$544.53	12+14+9+3 = 38	$14.33
C1	$882.13	8+4+8+10+11+5 = 46	$19.18
Contract 1 (26 B1)	$13,117.84	910+90 = 1000	$13.12
Contract 2 (55 A1)	$10,793.98	605+60 = 665	$16.23
Contract 3 (55 A1 + 20 C1)	$25,499.40	605+60+820+150 = 1635	$15.59

Remark: The thoughput per product unit can be found in the Finance View under Product Throughput Summary. For the contracts the throughput (look at the Finance View, Information, Contract Throughput Summary) considered is for one full shipment. The setup time is calculated not per unit, but assuming one setup per operation. Note that the values of the throughput change a little with time due to minor changes in the value of the materials due to shipping costs and possible purchasing from the more expensive supplier.

The calculated throughput per constraint's unit (T/CU) generates a clear priority criterion. It appears in the last column, which is simply the ratio between column 2 and column 3.

The underlying assumption is that M4 is the constraint (the limiting factor to higher profits). If we sell only C1, M2 will become the bottleneck. Still, under the assumption that we sell all three products, M4 looks as the constraint to the potential increase in sales. The above table shows a tendency to prefer products A1 and C1 to B1. It further prefers Contract 2 (55 units of A1) to both Contract 1 (the existing contract) and Contract 3 (for A1 and C1).

The above priorities are very different than the one product costing implies. It leads to different strategic and tactical decisions. The Production policies should still be evaluated. The obvious means to enhance sales is to reduce the quoted-lead-time (QLT). The other choice would be to reduce the price and thus lower the throughput per unit. In order to support the reduction in QLTs and in view of the excess capacity, some changes should be introduced to the production policies: reducing the batch size, allowing partial work order (WO) to be worked on, and activating the material requirements planning (MRP) module every day instead of once a week.

In view of the need to enhance sales while keeping the reputation of the company intact, **Purchasing should only seldom choke the production resources**. Either the MRP module should be active at the Purchasing department, ensuring adequate need dates are specified, or the order levels should be high enough to ensure availability of materials. Both methods should be based on the feedback of the control system.

Initial Decisions

Marketing and Sales considerations: It is quite clear that the QLT could be shortened considerably. The very significant amount of idle time is a certain signal that queue times should not be too large. The batch of 60 units is most certainly too large. Have another look at the utilization table above. The highest setup is required by M1 (5.2% in November and 4% in December), but M1 has a lot of excess capacity. It seems to be pretty safe to cut the batch size by half to 30 units.
This and other policy changes in the production floor should enable us to cut the actual lead-times and thus allow us to reduce the quoted-lead-time (QLT). This situation is ideal since customers desire earlier deliveries (at least in this virtual case), and by offering faster deliveries we expect to gain **more sales.**

Should we reduce the QLTs on all three products? As both A1 and C1 are preferable to B1, the reduction of QLT on both, while keeping the current sales volume of B1, seems to yield more benefits. Certainly when we do not know how much more demand will be generated we should

keep in mind that we have limited capacity on M4. As A1 is a much higher volume product we should be more careful in reducing the QLT for A1. Note that as C1 is a much more complex product than A1, it takes more processing time to complete a batch of C1 than to complete A1. However, the net processing time is usually small relative to the queue time. The queue time depends mainly on the load of the most loaded machine. Hence, we should be more concerned with the possible increase of demand for the higher volume product than for a more complex product.

In addition to that, some buildup of finished good inventory can provide an extra protection mechanism against incidental delays of some work orders. A serious cause for concern that can be benefited from finished goods inventory is the peak of demand from August until October. If we prepare some inventory when capacity is still available, it would be easier to go through the pressure of the peak.
We deal here with making decisions in a very uncertain environment. We can still be pretty sure that reducing the lead time on C1, our best profitable product according to TOC, from 6 weeks (30 days) to mere 4 weeks (20 days) is quite possible, even if the demand will grow significantly. Let us be more careful with A1, the high volume product, and reduce the QLT to only 5 weeks (25 days) initially. We will keep product B1 lead-time the same as now — 6 weeks (30 days). We would like to reevaluate the above decisions after three months. Note that the above decision should encourage the sales to the small customer market. We know that a new contract, for 55 units of A1 per month, will appear. As is quite clear, that contract is the more desirable from all the contracts, in spite of generating less throughput per unit that selling A1 to small customers. The decision at the point of the appearance of that contract is to accept it.

We should be reluctant to any changes in the selling price. Reducing the selling price in order to boost sales can work only when the amount of additional sales is way above the price reduction. Since throughput is the net contribution of any additional sale and it includes the cost of materials, a reduction in the selling price of 5% means reducing the throughput by more than 5%. For instance, reducing the price of A1 from $500 to $475 means reducing the throughput of A1 from $236.11 to 211.11, a reduction of more than 10%. If sales of A1 would go up by 10% the profit would be the same, but excess capacity would be drained. So, the right way to attract more sales is to use the existing excess capacity to generate more value to the customers.

Production strategy: Production should support the sales scheme to enlarge the market demand, at least up to the point of the available capacity (most likely just on M4). All the policies should consider the objective of being able to respond faster.
The initial material release policy is using the MRP option with a 4-day lead-time between subsequent operations. This is not strictly the standard MRP, but treating each operation as a separate level within the bill of material (BOM) can be accepted for this case. Should we consider 4 days for each level in the routing? Some materials go through 7 operations and thus, according to this policy, are released 28 days before the due date. As we consider shortening the QLT for C1 to a mere 20 working days, this means the materials would be released immediately, but later than what this algorithm determines. Reducing the MRP lead-time to 3 days seems adequate.
In the Work Center Policy entry all Complete WO entries should be changed to Partial Orders. The Complete WO does not allow splitting the batch over several work centers. This is the case

for too many real ERP/MRP implementations where each operation has to complete the full batch before it can be transferred to the next one. The change from Complete WO to Partial WO may cause just a few additional setups, but is going to dramatically improve the flow of materials, significantly reducing the actual lead-times.
Another aspect appearing in the Work Center Policy is the dispatch policy. All work centers are given Save setups policy. Clicking on the arrow to the right of the policy reveals a more appropriate policy: earliest due date (EDD). Such a policy would waste setups but would give precedence to orders that need to be shipped sooner. As long as M4 is not a real bottleneck the EDD policy should be used on all work centers. Once M4 starts to be a constraint in the TOC meaning the policy for M4 should be reevaluated.
The policy titled Work Order Planning also has two policy items. The first dictates the frequency of running the planning. There is not much point is generating new work orders only once a week. This in itself adds 2.5 days to the average lead-time and 5 days on some of the orders. The latter part causes the more significant damage. So, we should plan every day instead of once a week.
The batch size was briefly discussed in the marketing and sales decisions. The batch should be reduced to 30 units.
The Red Line Level Policy is a simple implementation of the buffer management control (please, refer to chapter 2). Here one just defines the number of days before an order is due that the user wishes to get a warning that the order is not ready to ship. The reader might ask why such a warning should be placed ahead of time. If you truly mean to ship **every** order of C1 in a mere 20 working days, it is reasonable to expect that most orders would be ready in 15 working days. With orders that are too close, the user should better take notice and push them through the production shop. Let us give 3 days of prior warning for any order that is not ready to ship within 3 days. Since the dispatch policy also should give some automatic preference to red orders (orders that crossed the red line have to be shipped in 3 days or less) mark the box titled Red Line Level Policy.

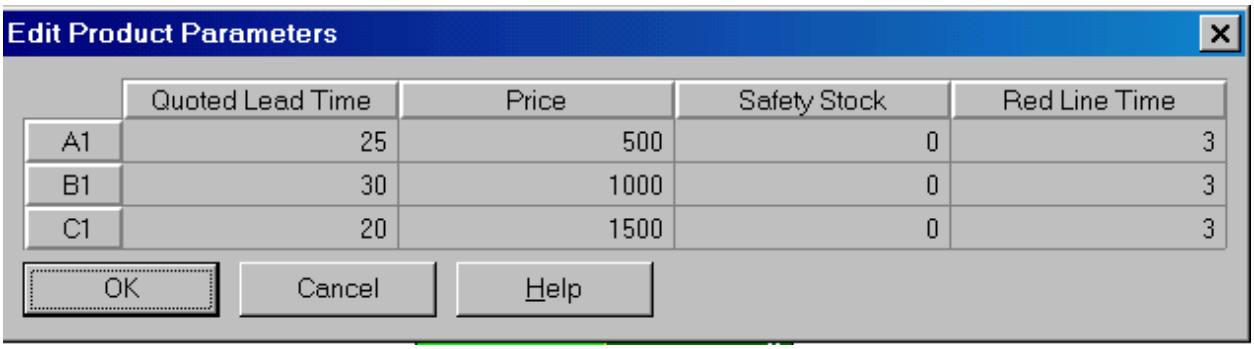
Purchasing policies: When we come to the Purchasing View, we need to set the parameters afresh. We still intend to work with the Regular supplier. However, the Order Level needs to be set to allow **at least** 2 months of inventory. Then, the Max Level is set so the purchasing orders will be between 200 to 300 units. The Red Line Levels are adjusted too without trying to be too precise. The concept of the 'red line' is similar to that in the production. It defines an emergency zone where a warning is issued.
The following description states the exact numbers to be inserted in the appropriate fields.

Actual Run Description:
Initial Actions

Please enter the decisions *exactly* as stated here. Decisions means any change to current parameters. You can move between the views and open the information menus freely. Refrain from going into entries within the Actions or Policies without being refered to by this document. This is a guided run, with more actions and explanations. After going through this you will be able to test any other method or decisions.

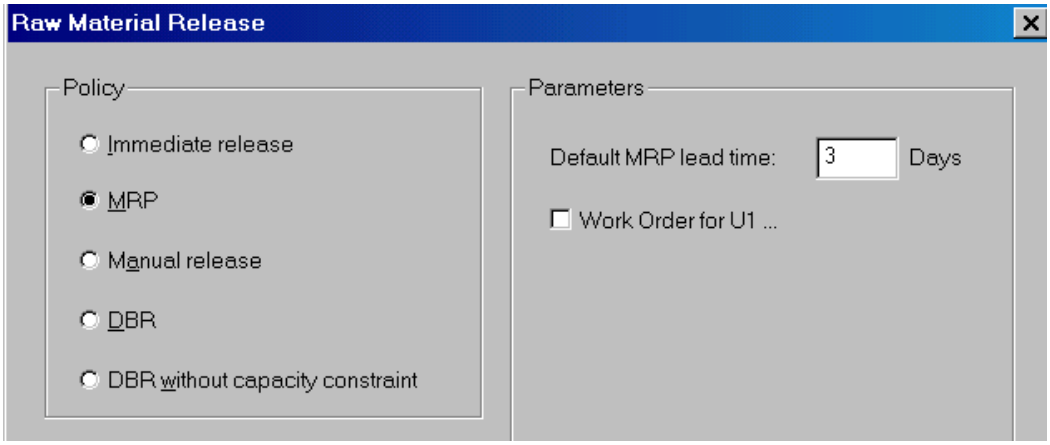
Actions at the Marketing View:

Product A1: Set the QLT to 25 days.
Product C1: Set the QLT to 20 days.
The Red Line Time should be set on 3 days.
The policies at the Marketing View should appears as shown:

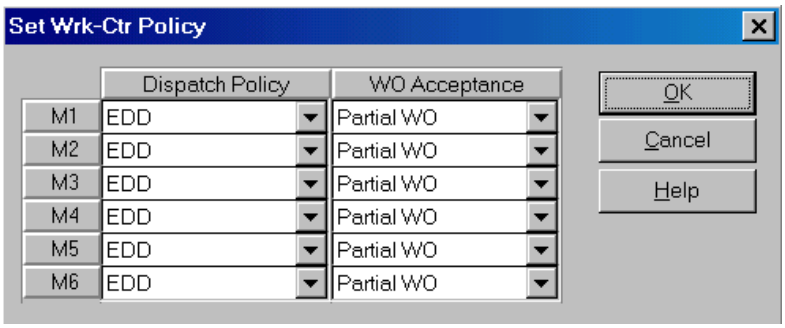


	Quoted Lead Time	Price	Safety Stock	Red Line Time
A1	25	500	0	3
B1	30	1000	0	3
C1	20	1500	0	3

Action at the Production View:
In the Production policies, the Raw Material Release policy should be changed to MRP with just 3 days lead-time.



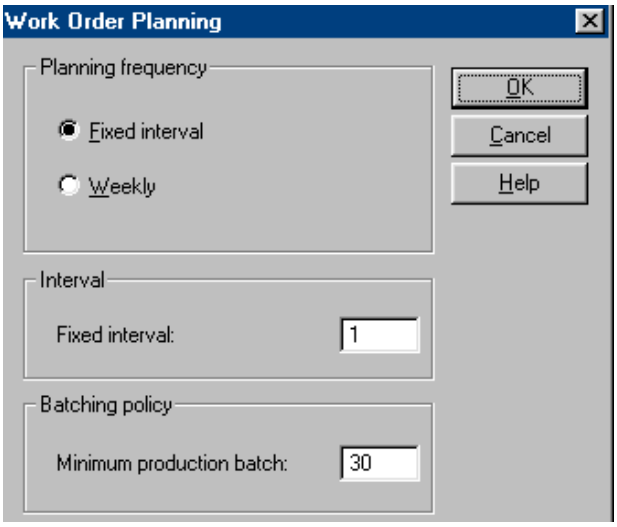
In the second entry of the Policies of the Production View, Set Wrk-Ctr Policy, make the changes discussed above so the window would look like this:



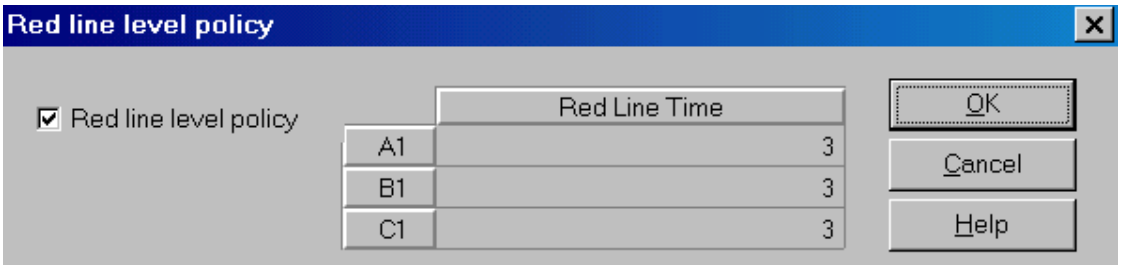
	Dispatch Policy	WO Acceptance
M1	EDD	Partial WO
M2	EDD	Partial WO
M3	EDD	Partial WO
M4	EDD	Partial WO
M5	EDD	Partial WO
M6	EDD	Partial WO

All Complete WO policies have changed to Partial Policies.
All Save setups have changed to EDD.

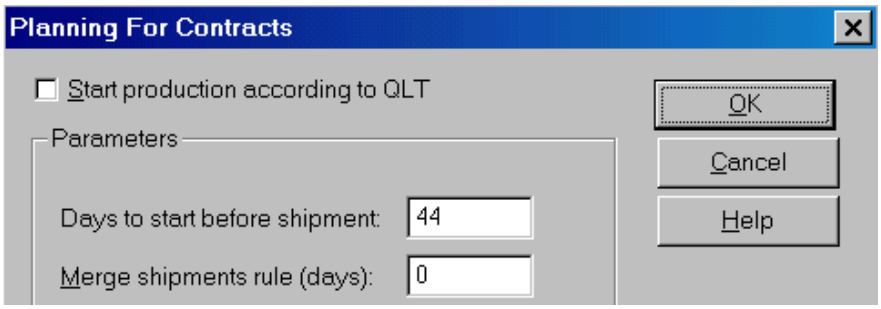
Next in the policies of the Production comes the entry of Work Order Planning. The Weekly planning frequency should be changed to Fixed Interval–1 day, meaning planning new work orders every day. The batch size should be reduced to 30 units. This is how that screen should look:



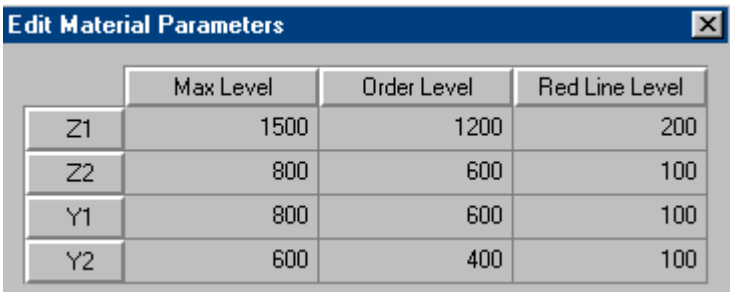
The Red Line Level Policy should look like this:



The Red Line Time is expressed in days and is exactly what also appears in the Edit Product Parameters screen in the Marketing View.
The Planning for Contracts policy determines when the demand of the contract should enter the plan. Since this contract is for a whole year the question is when to plan a future shipment. Since the material release is governed by the MRP function one could (as most packages do) consider all the shipments. However, planning a shipment that is due in 6 months when the lead-time is about 1 month does not add any value. For this run, planning any shipment two months ahead of time is more than enough. The defualt value in the screen is what you need (44 working days are equivalent to 2 months).



Purchasing: The following levels should be entered at the Purchasing View's Policies:



	Max Level	Order Level	Red Line Level
Z1	1500	1200	200
Z2	800	600	100
Y1	800	600	100
Y2	600	400	100

Remark: It is recommended to truly enter all those policies. These initial policies are also stored as a policy file. If you repeat the run and get bored with entering all these numbers, click on Session, Load Policies, mark the policy called erpbook-analysis.plc and click on Open. You can also save a set of initial policies that you like to test. Please save it under different name than erpbook-analysis.plc.

The Guided Run Details

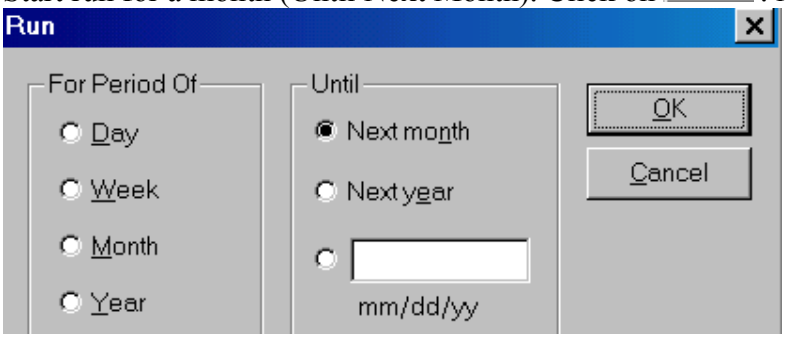
January 1, 2002

Actions

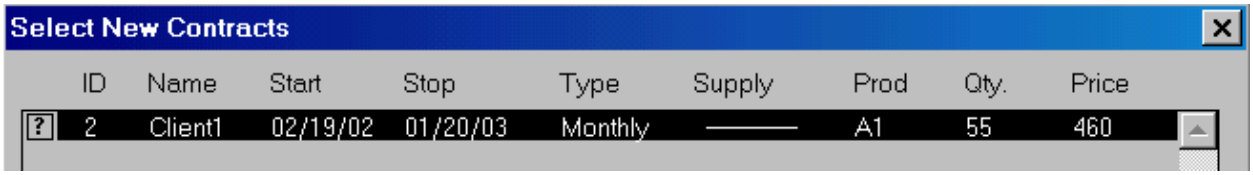
After entering all changes, we recommend you go to the Production View and invoke the View Graph option (upper-right of window).

Start run for a month (Until Next Month). Click on

. Mark Next Month and click OK.



On 1/10/2002, Contract 2 will be displayed.

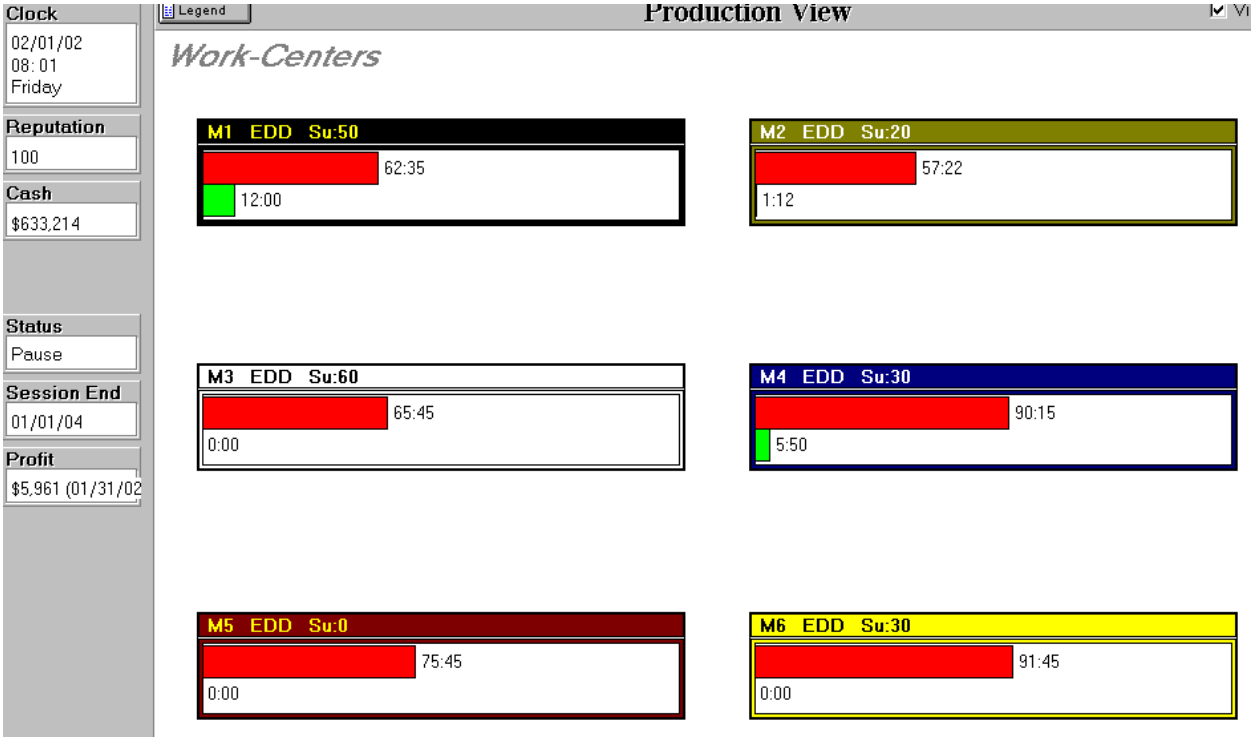


You may put it into Hold and look at the Rough Capacity Check at the Production View and the relevant screens at the Finance View (Contract cost analysis and Contracts throughput summary). After that you should click on Restore Hold (upper-right of screen) and accept the contract (click Yes and OK). The run resumes after you authorize the decision.

February 1, 2002

Results Review

During the previous run no problems were spotted — no red warnings were viewed.



Remark: Please check that you got the same state. If not, there might be a small discrepancy between the policies stated above and what you have entered.

An observation: The Work-in-Progress (WIP) level, the summation of all the green bars, shows that very little WIP is in the shop. This is due to reducing the MRP lead-time to 3 days. This fact makes the earliest release of materials to be up to 21 working days before the order is due. Any order for A1 has a due date of 25 days from accepting the order. Orders for B1 are promised delivery in 30 days, but the materials are released 21 days prior to the shipping on 1 leg and 18 days for the other.

The contracts shipments enter the planning and appear within the red bars, two months before the due date. However, materials are still released only 21 days or less prior to the due date. From what we see it works pretty fine. There is no need to release the materials earlier.

Actions
Run until next month.

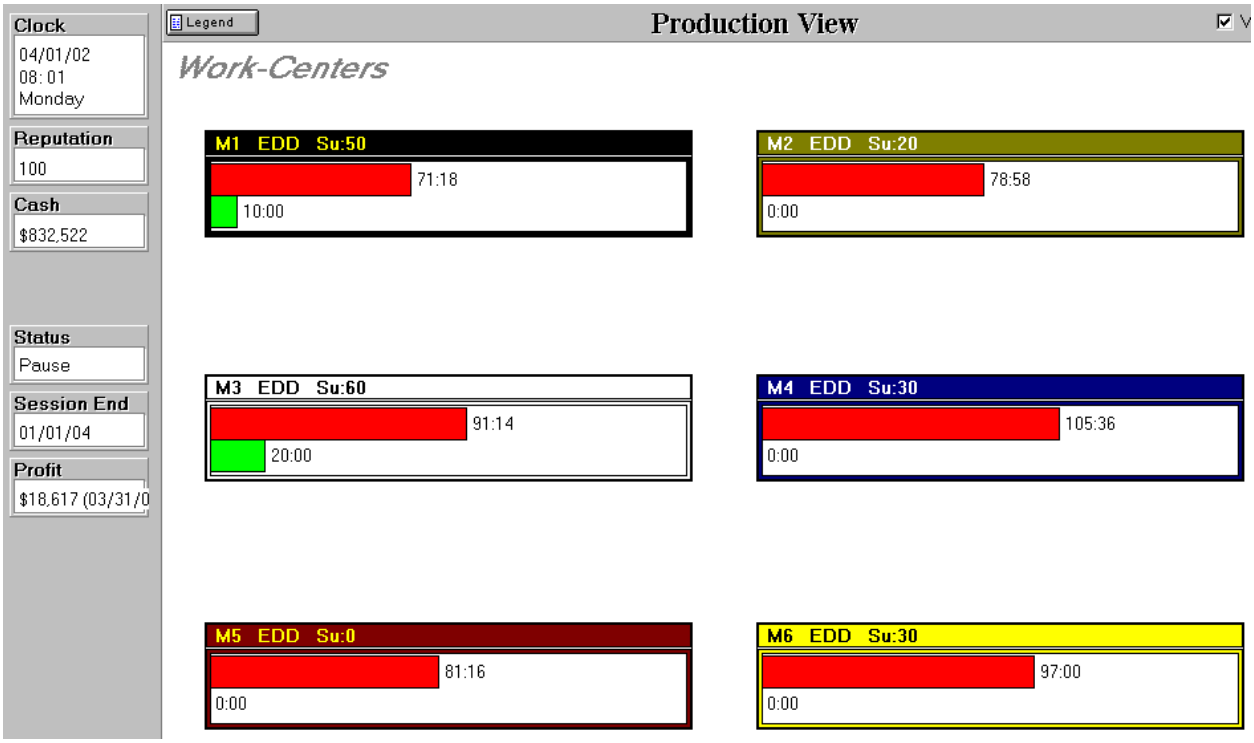
March 1, 2002

Results Review
Nothing special to report. No red warning was displayed. This means that all the orders were actually ready to be shipped at least 3 days before the due dates! Should we reduce the QLTs? The decision here is to wait until the end of the first quarter — just to be on the conservative side.
The accumulated profit, after tax, for the two first months is: $6650.

Actions
Run until next month.
On 3/20/02, the run is interrupted by the option to extend the contract of B1. According to the analysis above, this contract is the least desirable. Reject the offer to extend the contract by marking the No field and clicking on Continue. The run should resume until April 1.

April 1, 2002

Results Review
Let us view the total load graph for the end of the first quarter:



Note that M4 is idle now as no work is currently piling at M4's site. The length of all the orders to be processed by M4 is 105 hours — a little more than 2.5 weeks. This includes all the orders to be shipped in the next 4 weeks, A1 orders to be shipped in 5 weeks, orders for B1 to be shipped in 6 weeks, and all the contracts for the next two months. And M4 has the longest planned load! It has just 2.5 weeks for more than 4 weeks of shipments. This should be seen also in the utilization table (Production View, Information, Wrk-Ctr Utilization):

Wrk-Ctr Utilization

	March				February			
	Prod.	Setup	Break	Idle	Prod.	Setup	Break	Idle
M1	49.3%	12.9%	3.1%	34.7%	52.8%	15.1%	7.5%	24.6%
M2	60.4%	4.6%	10.3%	24.7%	64.4%	4.6%	5.8%	25.3%
M3	64.5%	8.8%	5.3%	21.4%	59.5%	9.6%	5.2%	25.7%
M4	72.1%	10.1%	6.2%	11.6%	80.8%	10.6%	8.3%	0.4%
M5	54.3%	0.0%	7.3%	38.4%	65.4%	0.0%	4.9%	29.7%
M6	67.8%	2.7%	2.1%	27.4%	66.2%	3.8%	8.0%	22.1%

Certainly M4 is relatively the weakest link, but it is far from being a bottleneck. Since no red warning was displayed all the orders were ready at least 3 days before the due date.
Before deciding to offer even more reduced QLTs, let us have a look at the Rough Cut Capacity screen. Remember the seasonality impact. The forecast algorithm for the next 6 months takes the seasonality into consideration.

Rough Cut Capacity

Range: 6 days Months

	Quantity
A1	1740
B1	420
C1	180

	Production	Setup	Break	Total
M1	47.9%	12.5%	3.0%	63.4%
M2	57.9%	4.4%	10.0%	72.2%
M3	59.7%	8.1%	5.0%	72.8%
M4	65.1%	9.2%	5.6%	79.9%
M5	55.9%	0.0%	7.6%	63.5%
M6	61.5%	2.4%	2.0%	65.9%

It seems M4 can do more. So, as we can reduce the QLT and enlarge the sales, let us do it!

Actions

Reduce A1's lead time to 20 days.
Reduce C1's lead time to 15 days!
Ensure you entered these instruction for the Product Parameters screen at the Marketing View, Policies.

Edit Product Parameters

	Quoted Lead Time	Price	Safety Stock	Red Line Time
A1	20	500	0	3
B1	30	1000	0	3
C1	15	1500	0	3

OK Cancel Help

Do not forget to click OK.
Run for one more month.
At 4/15/2002 the run is interrupted because of yet another new contract. This contract is less desirable than Contract 2 for A1 (see the above analysis). This is a pretty large contract for 55 units of A1 and 20 units of C1.
Since we can get more of A1 and C1 for the small customers market, let us stick with this sales strategy and reject the contract! Make sure you click first on No then on OK. The run should immediately continued.

May 1, 2002

Results Review
The accumulated profit is now $40,259.
There is nothing much to report. The load is still much less than what M4 can tolerate. Actually the load came down a little, but M4 is not idle at the moment.

Actions
Run until next month.

June 3, 2002

Results Review
During the run a brief appearance of a red warning was seen. The load (and profits) rose quickly.

Actions
Since we need to be careful, we should now run in weeks.
Run for one week!

June 10, 2002

Results Review
No red warning. The load on M4 (the red bar) is now 146 hours and 49 minutes.
The increase of the planned load on M4 shows it is turning to be a bottleneck. When the load keep increasing it means more new work is coming in than M4 can successfully process and move out.

Actions

Run for another week.

June 17, 2002.

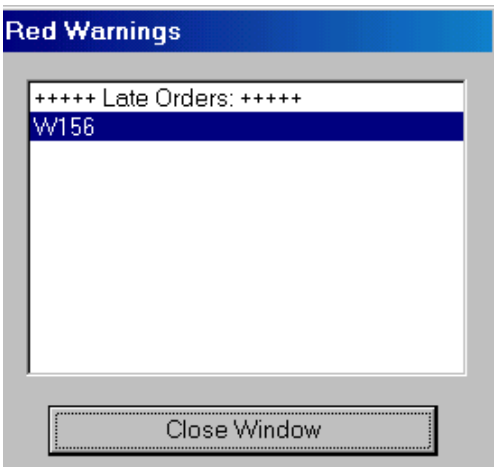
Results Review
The load on M4 is now slightly reduced a little bit.

Actions
Run for another week.

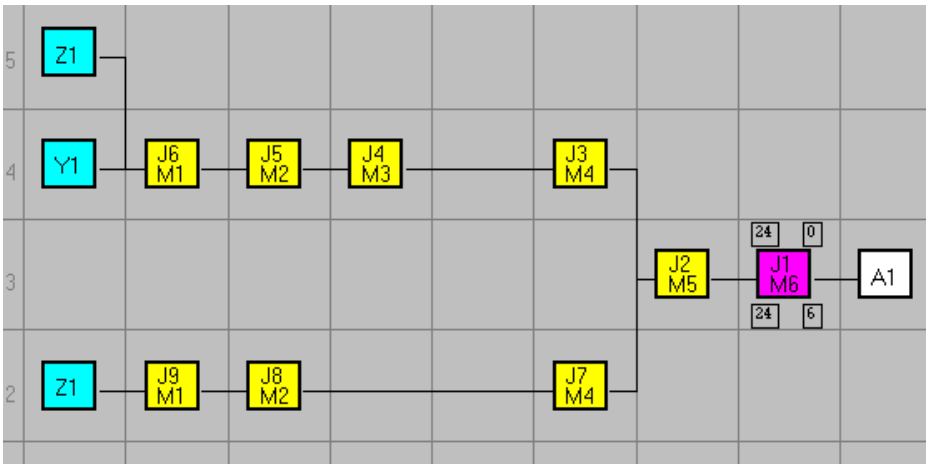
June 24, 2002

Results Review
The red warning is lit:

Click on it. It will open and show the following:



Double click on the late order line and a window with the current state of the late order would open:



All the operations except the last one are completed. The M6 work center actually works now on that particular work order (the purple color tells us that). Six units (the number at the bottom right) have already been completed. The M6 machine has still 24 more units to go.
Do we need to call an extra second shift to complete this work order? The option of overtime has been implemented here only for a whole second shift — all the shop for a whole 8-hour shift! Suppose the union has such a clause in the contract with the management.
The time-per-part of work center M6, operation J1 is 15 minutes. You can find it in the Production View, Information, All Products Routing. It seems all the 24 units can be processed in the next 8 hours of the regular shift.
There is no need for extreme measures.

Actions
Run until the end of the month!
Note that when you click on 'Run', mark the field: Next month, the second column first entry. Then click on OK.
If you clicked by mistake on a week run, then by clicking on 'D' you proceed 1 day more until July 1.

July 1, 2002

Results Review
The red warning is still lit. Open it:

Work order 158 appears twice. **Do not pay any attention to that!**
Work order 158 is at its final operation with only 17 units to finish processing at the M6 work center. In other words, it will be finished today without any need for a second shift.
The other entry in the Red Warning window is material Y1. Click on the material and you will be switched to the purchasing screen. Close the Red Warning screen. We see that the upper left part of material Y1 is red. The on-hand quantity is just 25 units, which means that no manufacturing work order is lacking materials — otherwise the on-hand would be zero. However, 25 units are definitely below the red-line level for Y1.
Should we order urgent delivery of Y1? The policy that we set for Y1 dictated the quantity of 100 items to be the emergency zone for Y1. We should quickly bring more Y1 items.
Click on the Actions menu of the Purchasing View and then on Suppliers. You get the following window:

Suppliers

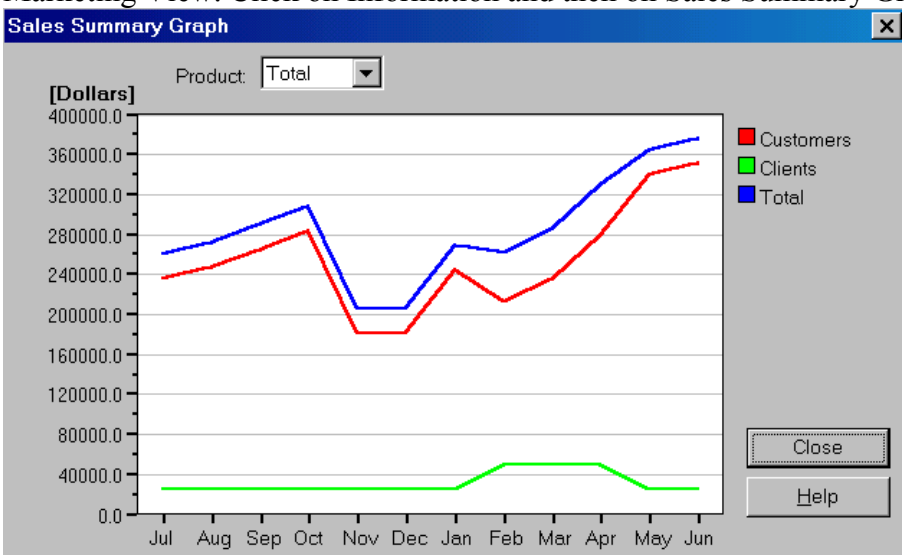
	Name	S.C	QLT	Z1	Z2	Y1	Y2
1	Reg	500	22	(C) 100	(C) 150	(C) 60	(C) 50
2	Fast	650	3	115	175	72	58

The S.C. column denotes the fixed shipping costs. It makes sense to order special delivery from the Fast supplier, hopefully supplying in 3 days. How much should we order? The difference in price for Y1 between the Reg supplier and the Fast one is $12 per item. So, the decision for this particular guided run is to buy 100 Y1 items. Close the Suppiers window.
The simulation is now halfway through. Do you remember the decision about the batch size? Let us check now how significant are the setup times.
Go back to the Production View (click on Production at the top). Click on Information and then on Wrk-Ctr Untilization. This is the current utilization for the May and June:

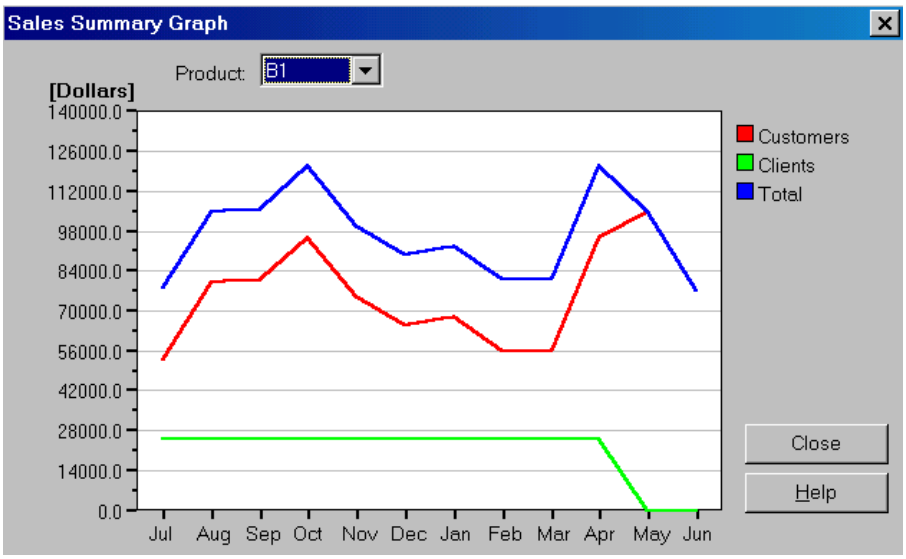
Wrk-Ctr Utilization

	June				May			
	Prod.	Setup	Break	Idle	Prod.	Setup	Break	Idle
M1	72.0%	21.9%	6.1%	0.0%	62.8%	16.3%	14.5%	6.4%
M2	83.4%	6.9%	7.6%	2.2%	84.6%	6.7%	7.0%	1.6%
M3	79.6%	10.0%	6.5%	3.9%	83.8%	7.6%	8.5%	0.1%
M4	83.1%	10.6%	6.3%	0.0%	81.8%	10.6%	7.6%	0.0%
M5	71.4%	0.0%	8.3%	20.3%	66.5%	0.0%	7.4%	26.1%
M6	76.1%	2.2%	16.6%	5.2%	75.3%	2.2%	7.1%	15.5%

In both months the setup for M4 is over 10%. In June M1 did not have any idle time with a very high percentage of its capacity going to setups.
Let us also watch the sales graph. For that click on 'Marketing' at the top to move to the Marketing View. Click on Information and then on Sales Summary Graph. This is what we see:



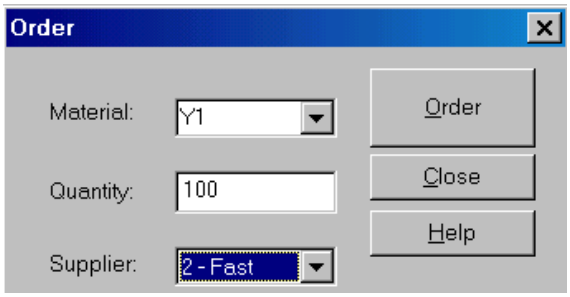
The market certainly responded well to the QLT reduction. Now we are approaching the seasonal peak. Let us see what happened to the market for B1, which is the least preferable product we sell:



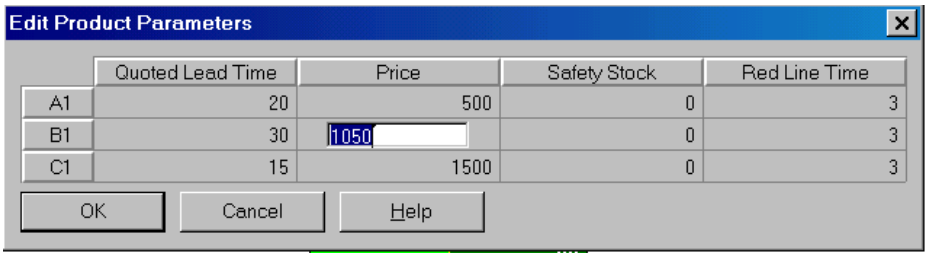
The green line represents the contract for B1 that has not been extended. The total sales for B1 then came down, but we still sell a lot of B1. When there is a pressure on M4's capacity should we continue with selling that much B1?
Our suggestion is to raise the batch size to 40 to reduce a little of the waste of capacity of M4 on setups and also to raise the selling price on B1 by 5%.

Actions

First, let us buy 100 units of Y1. Click on Purchasing at the top of the screen. When you are in the Purchasing View, click on Actions and then Order.
Click now on the down arrow opposite to Material and choose Y1.
In the quantity field write 100. Click on the down arrow opposite to Supplier and choose Fast.
This is how it should look:



Click on Order, confirm, and close the window.
Now move to the Marketing View by clicking on Marketing at the top. Open the Policies and the Product Parameters. Go to the Price column of the B1 product and change the price to 1050 ($ per unit). It should look like this:

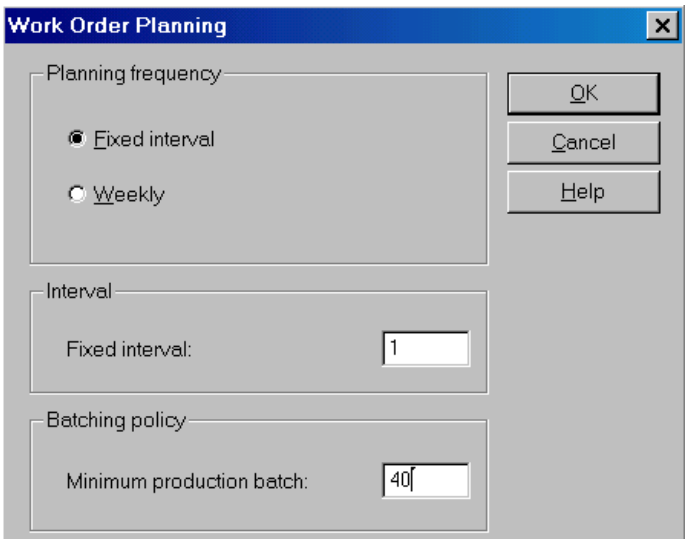


Edit Product Parameters

	Quoted Lead Time	Price	Safety Stock	Red Line Time
A1	20	500	0	3
B1	30	1,050	0	3
C1	15	1500	0	3

OK Cancel Help

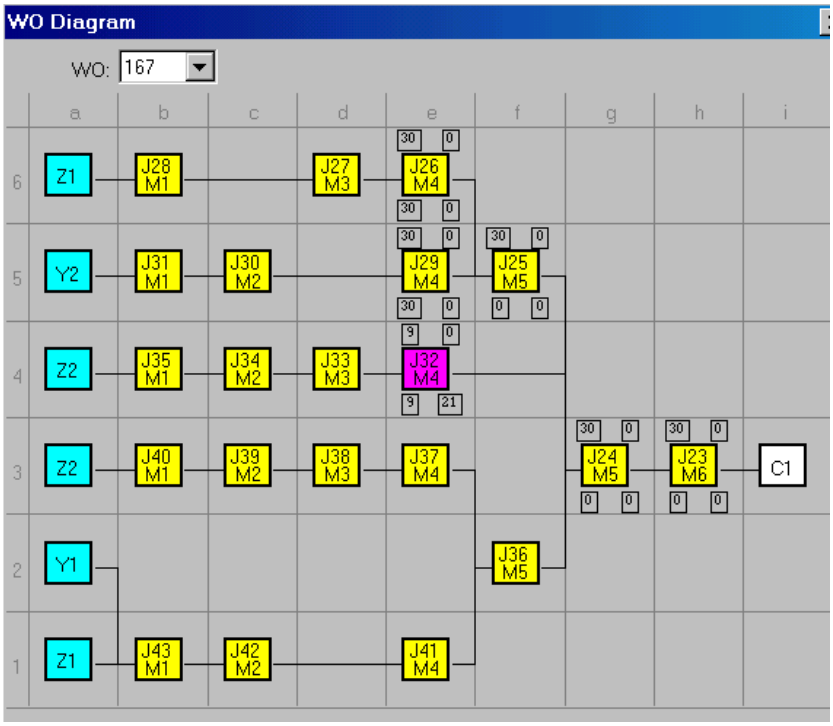
Click on order to confirm.
Now go to the Production View. Open the Policies, Work Order Planning, and change the minimum production batch to 40:



Click on OK.
Now run for just a week until July 8

July 8, 2002

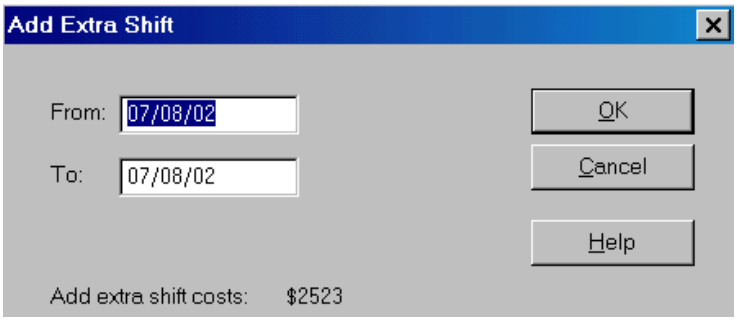
Results Review
The red warning kept showing throughout the week. Click on it. It shows one order: WO 167. When you double click on it you get the actual state of that order:



The order is stuck behind M4. M4 is busy processing operation J32, with 9 more parts to go. But two more M4 operations are still needed. You could calculate how much time M4 needs to process all these operations and then the M5 and M6 operations. Close both windows. The decision now is to add today a second shift to ensure the timely completion of WO 167.

Actions

In the Production View, click on Actions and then on Add Extra Shift. You should get the following:



Confirm the request to go to second shift on 7/8/02 (this is the current date in the virtual organization) by clicking on the OK button. Note that the cost of going into second shift is: $2,523.

Run for one week!

July 15, 2002

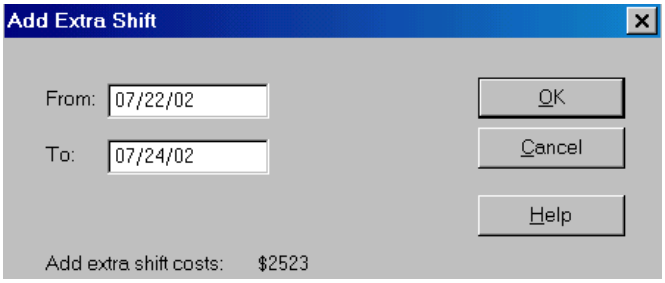
Results Review
Clicking on the red warning we see that material Z1 is in the red. No orders are late. All we need to do is to buy 320 units of Z1. We need 200 units to be above the red line. Then if you go to the Purchasing View, Information, and Unsupplied Units you can see that 120 units are now required but missing.

Actions
Close the Red Warnings window. Go to the Purchasing View. Click on Actions and then Order. Fill in the quantity of 320. Change the supplier to Fast. Click on Order, confirm, and close the window. Move back to the Production View (recommended).
Run for another week!

July 22, 2002

Results Review
The red warning now includes two late orders. The planned load on M4 went up to 180 hours and 33 minutes. It means there are 4.5 weeks of continous work to deliver orders and that some of them are for 3 and 4 weeks from now. Other orders are for 5 weeks and the contract orders have more time, but this means huge pressure starts to build.
Let us add three consecutive second shifts in order to reduce the pressure.

Actions
In the Production View click on Actions and the Add Extra Shift. The current date is 07/22/02. Change the To date to 07/24/02.



Run for just 1 week until July 29.

July 29, 2002

Results Review
The pressure on M4 is still 4 weeks (163:39). The red warning shows Y1 is below the red level and there are two red orders — 177 and 179.
Let us now buy 150 units of Y1, as the last purchase of just 100 was not enough.
Let us also add another 2 consecutive shifts to reduce the load on M4.

Actions

Go to the Purchasing View. Select Actions, Order, Y1, 150, Fast, and then Order. Confirm and close the window.
Go back to the Production View. Select Actions, and then Add Extra Shift. Change the To date to 07/30/02 (this would add shifts on the July 29 and 30). Click OK.
Run until next month only (August 1).

August 1, 2002

Results Review
The reputation went down to 99. This is not too serious, especially at the peak.
The main point is that the pressure on M4 dropped to less than 4 weeks.
We should run week by week, but as the pressure went down, let us take the chance and run for the whole month.

Actions
Run until next month (September 2).

September 2, 2002

Results Review
The profit is now: $197,687. So, we do well with all the efforts, but the pressure is back. The load on M4 is now over 4.5 weeks. As long as there is this pressure you should run the simulation week by week to find out whether second shifts are necessary.
Y1 is still in the red. We need to buy more and we need to readjust the regular inventory levels for Y1.

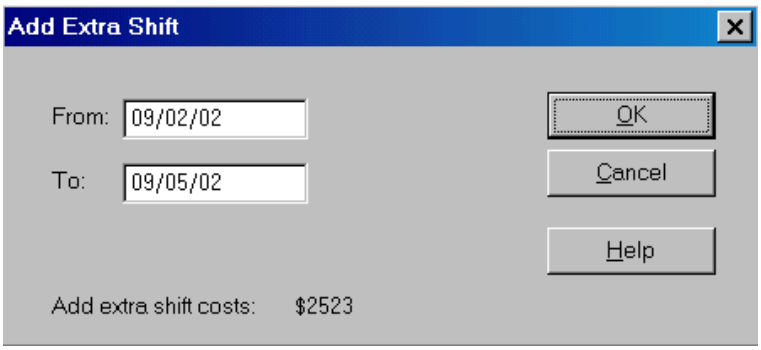
Actions
Go to the Purchasing View. Select Actions, Order, Y1, 150, Fast, and then Order. Confirm and close the window.

While still in the Purchasing View, open the Policies/Material parameters. Change the levels for Y1 to: Max: 1000, Order point: 800.

Edit Material Parameters

	Max Level	Order Level	Red Line Level
Z1	1500	1200	200
Z2	800	600	100
Y1	1000	800	100
Y2	600	400	100

Click OK.
Go to the Production View. Select Actions and then Add Extra Shift.
We will add four extra shifts in a try to reduce the pressure so the planned load on M4 will not be over 4 weeks. Change the To date of the to 09/05/02.



Run for just one week until 9/9/02.

September 9, 2002

Results Review
The pressure did go down. Two orders are in the red.

Actions
Add one extra shift. In the Production View select Actions and then Add Extra Shift. Then select OK.
Run for one more week until September 16.

September 16 2002

Results Review
Pressure is still building up. Three orders are in the red (ignore the fact that each of the order appears twice). Order 202, for product A1, is in the worst state.

Actions
Add two additional shifts. In the Production View select Actions and then Add Extra Shift. The To date should be changed to 09/17/02.
Run one week until September 23.

September 23, 2002

Results Review
Have a quick look at the Marketing View. Product A1 is red and in its "On time" field it is written: 80. That means at least one order is late. It is now too late to fix that. In the red warning list there are now four orders. One of them is WO 202. Since the red line time is 3 days and that work order was red a week ago, we certainly are late with this particular order.
We also need to buy emergency units of Z1.

Actions
In the Purchasing View select Actions, Order, Z1, 200, and then Fast.
Add two extra shifts. In the Production View select Actions and Add Extra Shift. The To date should be changed to 9/24/02.

Run until the end of the month (October 1).

October 1, 2002

Results Review
The profit is now $230,655. The reputation went down to 94, probably because of the lateness of WO 202. But, the pressure went down considerably. We have just one order in the red and it is already at the assembly operation.
Should we change the raw materials levels? Z1 has appeared several times below the Red Line Level. But now the peak period is over. Z2 and Y2 never appeared in the red, so let us reduce their Order Level, which is the real protector, and also their Max Levels to match the minimum order quantity.

Actions
In the Purchasing View select Policies and then Material Parameters. For both Z2 and Y2 let us reduce the max and order levels by 100 units. So, Z2 should have 700 as the Max Level and 500 as the Order Level. The Max Level for Y2 is from now 500 and the Order Level is 300. Both still have the Red Line Level as 100 units.

Edit Material Parameters

	Max Level	Order Level	Red Line Level
Z1	1500	1200	200
Z2	700	500	100
Y1	1000	800	100
Y2	500	300	100

Confirm the change.
Run until next month (November 1).

November 1, 2002

Results Review
The pressure went down very significantly. This is an opportunity to get more sales by reducing the QLT. Certainly with the reduced planned load on the products we can supply faster and get more demand.

Actions
In the Marketing View select Policies and then Product Parameters. Since Product A1 is the highest volume product we should be careful not to attract too much demand. The QLT of A1 should be 18 working days. Since the pressure on M4 went down, why not get more market for B1? Reduce the QLT to 5 weeks — 25 working days. We should be careful about C1, as we now offer it in 3 weeks delivery.
So, the suggested delivery times are now:

Edit Product Parameters

	Quoted Lead Time	Price	Safety Stock	Red Line Time
A1	18	500	0	3
B1	25	1050	0	3
C1	15	1500	0	3

OK Cancel Help

Click OK.
Run until nest month (December 1).

December 1, 2002.

Results Review
The market demand is still low. The potential of more profits are there if you dare to offer even faster response to the market demand. Since we are close to finish the run of 2002, we will be too conservative and change nothing.

Actions
Run until next year (January 1, 2003).
On 12/11/03 the contract for 55 units of A1 starts for renewal. Accept it by clicking on Yes and then OK.

January 1, 2003.

Results Review
The simulation run stopped to offer us an extension of the contract for 55 units of A1. This would impact mainly the policies for 2003. Please, confirm the extension by clicking on Yes and then Continue.
The profit after taxes is $270,640. The reputation is 97. Note the huge difference between the profit and loss statement for 2001 and 2002. When there is a loss no taxes are paid. Here the run, under the policies used, made $270K after the reduction of 35% tax.

Profit and Loss Statement

From: 01/01/02

☑ With added value on FG and WIP

To: 12/31/02

Sales	4,026,790
Cost of goods sold:	
Raw materials consumed	1,935,134
Direct labor	299,522
Production expenses	182,317
Depreciation	420,000
Production cost	2,836,973
Increase in FG inv	-66,850
Increase in WIP	38,690
Gross profit	1,161,657
Marketing and sales expenses	378,000
Management and general expenses	396,000
Profit before finance	387,657
Finance expenses	-28,713
Profit before taxes	416,370
Net profit	270,640

This is the conclusion of this guided run. You still can run for another year.

Main Points to Learn

- Concentrating on the load and performance of the weakest link (M4 in our case) could yield a lot of benefits.
- We can drastically cut lead-times by applying better operational policies and closely watch the queue of work (the planned load).
- Note the very different product mix priorities of TOC vs. the traditional cost accounting. According to the cost accounting calculations, product A1 is the least profitable. Is it?
- The Red Line Time set on the orders and the Red Line Level set on the raw materials provide very important, focused, and timely controlled information. Most ERP/MRP packages do not provide this information. Using simple external tools, such as Microsoft Excel, can easily provide this very simple control mechanism.
- Being focused on key information items could make huge difference. It is easy to draw more from this environment. Therefore, it must be possible to draw much more from your environment as well.