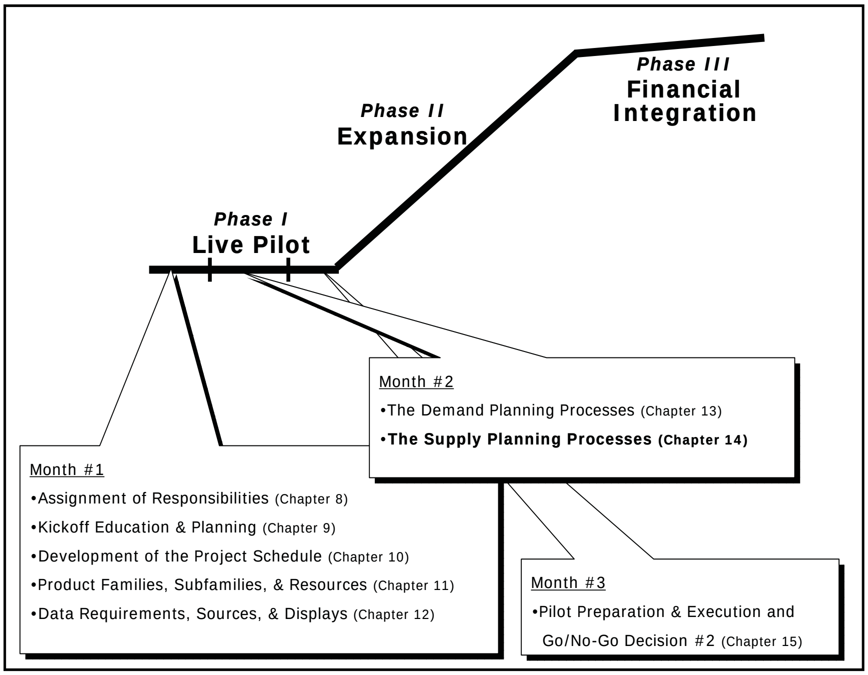
Chapter 14

The Supply Planning Process

Please note what's happening here: first we concentrate on demand, as seen in Chapter 13. Once the new demand picture is created, we can focus closely on the supply piece.



The Supply Planning[1] process, Step 3 in the 5-step monthly cycle, consists of five substeps, as shown in Figure 14-1 on the next page. We'll review them one at a time.

Review Supply Performance to Plan (3A)

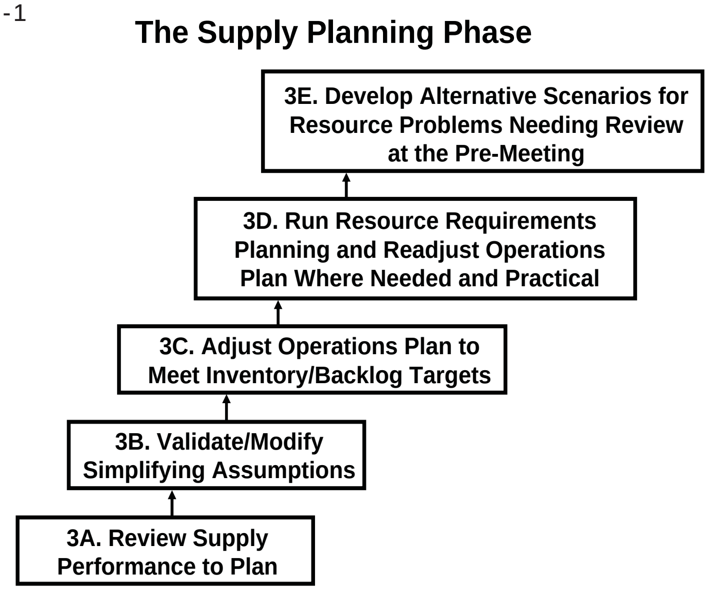
This step compares actual performance against the Operations Plan for the month just ended. This is done for both internal supply and outsourced products, and focuses on gaps — both over plan as well as under — between actual and plan.

All significant gaps are analyzed. Based on the cause, a variety of actions could result:

- Fix the problem. Determine the root cause and eliminate it.
- Work around the problem. If the root cause can't be eliminated, develop another way to get the job done, perhaps via reassignment of work to other resources.

[1] Many of the topics in this chapter were introduced in Part One. Here we'll get into more detail on them.

Figure 14-1



- Reassess the future capacity. Perhaps the desired output won't be attainable for some time to come, and this issue must be communicated widely and factored into future plans.

This part of the Supply Planning step can be done in parallel with the Demand Planning step.

Validate / Modify Simplifying Assumptions (3B)

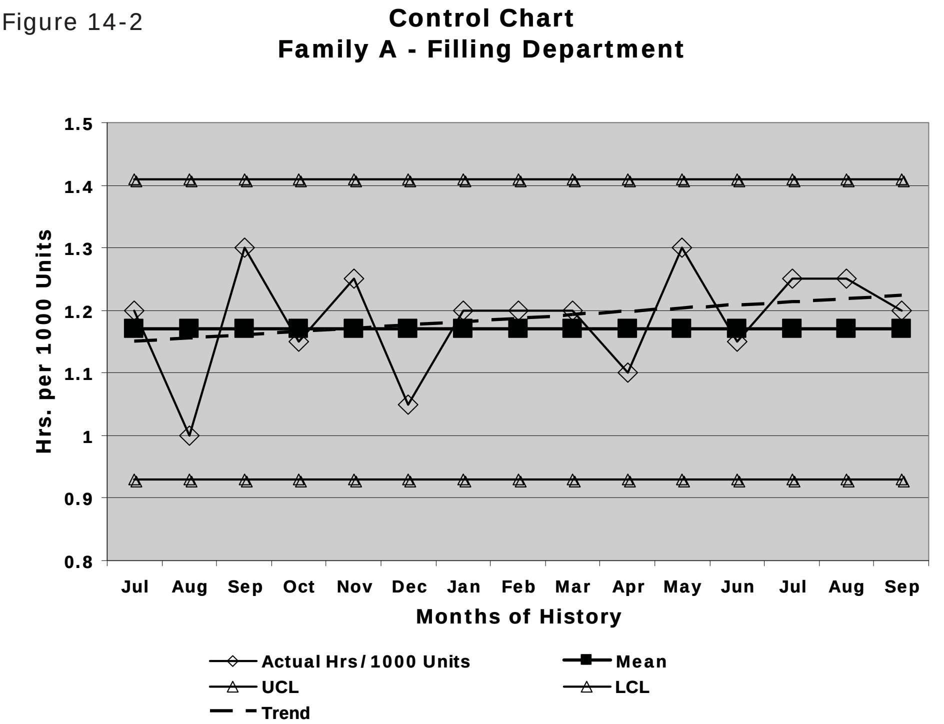
Several key sets of assumptions are involved here, one being the sales mix of individual products within a family. If that mix changes, and the various items in the family put different amounts of workload on a resource, then the values in the Bill of Resources (to be explained shortly) must be adjusted accordingly. Similarly, if the routing of one or more products has changed, that would probably require an adjustment to the Bill of Resources.

Another example: a resource has a change in its processing speed. Let's say that historically it's taken 1.2 hours in the Filling department to run 1,000 of Product Family A, but that during recent months, Filling has been running those products faster. It takes on average only 1.1 hours to make 1,000. This would call for a change in that factor in the Bill of Resources.

This step can also start before Demand Planning is finished, and we recommend that it be done every month. Figure 14-2 shows an example of how a control chart can be used to validate the simplifying assumption that it takes 1.2 hours of run time in the Filling operation to make 1,000 units of Product Family A.

This chart is a traditional TQM Control Chart. It shows the actuals for the last 15 months, with the mean being calculated and shown. Also shown is a trend line over those 15 months. The upper and lower control

Figure 14-2



limits (UCL and LCL) are based on three times the mean absolute deviation (MAD), which represent a 99.2 percent statistical probability that all plots in the future will be within those limits.

With this data updated each month, a judgment needs to made that the current assumption about run rate (1.2 hours per 1,000 units in this case) remains valid or needs to be changed. The trend line over these 15 months (seen on the Control Chart) indicates that the amount of time on the average (mean) to produce 1,000 units is increasing. This may or may not cause a change at this time, mainly because the last actual is right on target at 1.2.

It's not enough to verify the assumption (1.2 hours per 1,000), which is almost always an average, a mean. We must also check on the variability of that assumption, and typically that calls for updating the MAD. We'll return to this subject in Section 3D, below.

Adjust Operations Plan to Meet Inventory/Backlog Targets (3C)

First, a word about another preliminary step, this one with the S&OP spreadsheets. The Operations Plans from the prior month's spreadsheets are "rolled" one month to reflect the passage of time. The new end-of-month inventory numbers are entered, along with actual sales and actual production data for the month just ended. Then, when available, the new forecasts are entered into the spreadsheets.

With this, the Supply people are able to observe where the old Operations Plan (from the prior month) is causing the inventory and/or backlog projections to be higher or lower than target. They adjust the Operations Plan accordingly, thereby creating the new Operations Plan. As they do this, they are aware that they could be causing an overload — or underload — problem in one or another resource. They don't need to solve the problem then, but just know that it'll need to be addressed in the next step.

Run Resource Requirements Planning and Readjust Operations Plan Where Needed and Practical (3D)

This process makes use of the newly validated/updated simplifying assumptions from step 3A. They enable the Operations Plan for the individual families to be "translated" into units of workload for each resource. This process allows the Operations people to relate the required capacity (demand) to their available capacity (supply). They're able to evaluate the "doability" of the plan, changes needed in staffing levels, the need for new equipment, and so on.

The Mechanics of Resource Requirements Planning

The mechanics of Resource Requirements Planning are straightforward. It requires what are called Bills of Resources,[2] a kind of matrix that links product families to key resources.

Let's take a look at Figure 14-3, which shows a simplified display from a company making pharmaceuticals. This matrix tells us, among other things, that making 1,000 units of Product Family A will require, on average, 2.7 hours of time in the Mixing department, 1.2 in Filling, and so forth. The same kind of data is available for the other families, B through F.

Figure 14-3

BILL OF RESOURCES — FAMILY LEVEL (PER 000 UNITS)

KEY RESOURCES	FAMILIES					
DESCRIPTION	A	B	C	D	E	F
MIX (HRS)	2.7	5.0	13.1	—	1.8	14.0
FILL (HRS)	1.2	3.1	2.6	—	11.8	6.0
TEST (HRS)	1.6	2.4	1.1	0.7	—	7.0
LABELER #6 (HRS)	3.3	3.3	—	2.0	—	—
WAREHOUSE SPACE (CUBE)	6.7	3.3	—	2.6	—	19.0
SUPPLIER A (GALLONS)	8.7	6.7	7.1	—	4.2	—

[2] Also called Load Profiles.

Those numbers — 2.7 hours in Mixing, 1.2 in Filling and so on — are not only averages, as we said. They are also *assumptions* — the simplifying assumptions we've been talking about. They assume that the demand mix of individual products within Product Family A will stay the same, and that the process steps and speeds will not change.

Bills of Resources can be developed in several ways:

- by analyzing routings and calculating averages for all products within a family. (A weighted average, based on planned volumes, may be required if there are significant variances in the time requirements of different products within the family.);
- by pulling historical data from job cost records;
- by using estimates from knowledgeable people in Production, Engineering, and Purchasing; or
- by using some combination of the above, including judgments about the future.

Adding the Operations Plan into the picture enables the calculation of the Resource Requirements Plan for one month, shown in Figure 14-4.

Figure 14-4

RESOURCE REQUIREMENTS PLAN (ONE MONTH)

KEY RESOURCES	FAMILY PRODUCTION PLAN QUANTITY						CAPACITY		
DESCRIPTION	A	B	C	D	E	F	REQ'D	DEMO	MAX DEMO
	15,000	6,000	21,000	10,000	34,000	6,000			
MIX (HRS)	41	30	275	—	61	84	491	584	621
FILL (HRS)	18	19	55	—	401	36	529	450	482
TEST (HRS)	24	14	23	7	—	42	110	119	146
LABELER #6 (HRS)	50	20	—	20	—	—	90	77	136
WHSE SPACE (CUBE)	101	20	—	26	—	114	261	370	410
SUPPLIER (GALLONS)	131	40	149	—	143	—	463	500	640

Here we can see the result of multiplying the hours in the Bill of Resources by the amount of the Operations Plan. For example, multiplying Product Family A's 2.7 hours of work required in Mixing by the Operations Plan for Family A — 15,000 units — results in 40.5 hours, rounded to 41. Some interesting information is shown in the three right columns:

- The column headed “Capacity Req’d” (Required Capacity) is the sum of all the numbers to its left, representing the *demand* for capacity. To hit the Operations Plan will require that much output.

- The next column, “Capacity Demo” (Demonstrated Capacity) shows the *supply* of capacity, i.e., how much capacity we have available. Please note the word “demonstrated.” This refers to average actual output, often expressed in standard hours: what we have proven we can produce, as opposed to a calculated, theoretical output that we may or may not be able to hit.

- The right-most column, “Capacity Max Demo” (Maximum Demonstrated Capacity) refers to an upper limit of output that might be reached with heavy overtime or other means. Many companies will use this as a statement of capacity that can be attained for a relatively short time, not a level they’d like to operate at over the long run.

In Figure 14-4, we can see some problems, an obvious one being Filling. Required Capacity for the month is 529 hours, far in excess of the Demonstrated Capacity or even the Maximum. This says that the Operations Plan as it now stands is not producible. Something has to change, either via increasing the supply of capacity or decreasing the demand for it.

Using the Resource Requirements Planning (RRP) Information

The information in Figure 14-4 shows the picture on *all* of the resources for only *one month*. In actual practice, it’s usually the reverse: a Resource Requirements display will show only *one resource*, but for a *number of month*s into the future. See Figure CG-5 in the section of colored graphical displays at the back of the book, which shows a Resource Requirements Plan for Acme Widget’s subassembly operation. We suggest you open up that display so that you can follow along with the text.

The required capacity (red bars and green bars) can be related to the demonstrated capacity (blue band) and to the maximum demonstrated capacity (yellow band). The spreadsheet details that back this up can show more information such as actual numeric data, cumulative comparisons, year-end totals, and so on.

Using this information, the Supply Planning people can evaluate the overall load for doability. This resource seems to be capable of doing the overall volume of work if it runs at its normal capacity, with no overtime for many months. A moderate trend upward starts to appear about ten months into the future, which probably does not require action now but may be something to watch over the coming months.

The first step in developing Bills of Resources is to determine which resources to include. A few paragraphs ago, we used the phrase “key resources.” That implies that not all resources are visible to Resource Requirements Planning, just the key ones. These are often large resources, which could be entire departments, such as Filling.

Reasons to include a resource in the Resource Requirements Planning process include:

- It’s a bottleneck.

- It's not possible to offload work from this resource to another.
- It has a long lead time to change capacity (highly trained Production people).
- It's heavily involved with new products (perhaps Engineering people).
- It's costly to underutilize, such as equipment designed to run 24–7 and/or it's expensive to shut down and restart. Furnaces are a good example.

The resources being addressed can, of course, be production resources but also could be others. Material, warehouse space, refrigerated storage, shipping department personnel, cash, rail cars, trucks, and so on can be appropriate subjects for Resource Requirements Planning when they are constraints to producing and shipping product. In some of these cases, e.g., material, the driver is the Operations Plan. However, the driver for warehouse space would be the Inventory Plan and perhaps the Demand Plan would drive the calculations for shipping workload. In Finish-to-Order, the driver for the Finishing Department would also be the Forecast/Sales Plan.

Not all resources to be tracked need to be from within the company. Contract manufacturers and other key suppliers come to mind. For this kind of planning process, as we said in the Foreword, it's not really important who owns the factory.

Beware of including too many resources in this process. Dozens and dozens are probably too many. One good rule of thumb is to track a number of resources no more than double the number of product families, i.e., ten families, no more than twenty resources.

As with forecasting, many companies are able to do an effective job of Resource Requirements Planning at the family or subfamily level. This occurs when the families or subfamilies are fairly homogeneous, i.e., when the individual items within them create a fairly similar load on the resources. Other companies find that, closer in, they need to generate the capacity requirements from the Master Schedule (using a process called Rough-Cut Capacity Planning). This is because the individual products place widely differing loads on the resources. Hence, individual item detail is necessary in these cases.

In our experience, most companies don't need that kind of precision for projections many months into the future. Some companies feel they need such precision, but if you think your company may be in that category, make sure that you're not confusing precision with validity. Four-decimal-place "accuracy" isn't necessary; what's needed are valid numbers, directionally correct, upon which to base decisions.

Testing the Plan for Assumption Variability

The Resource Requirements Plan shown in Figure CG-5 is based on assumptions of resource consumption in Subassembly by medium widgets and large widgets. These assumptions will almost always be averages. As we all learned in statistics, the mean — one measure of central tendency — goes hand-in-hand with a measure of variability, typically measured by the standard deviation (sigma) or mean absolute deviation. Throughout this book, we've used MAD for our measure of variability, because it's easier to calculate and understand.

So, besides the assumptions of resource consumption, we need to know the variability. Let's say in this case (looking back at the Control Chart earlier in this chapter, Figure 14-2) the upper and lower control limit are set at 3 MAD to represent a 99.2 percent probability of maximum future variability. What that says is that in any short period of time, it could take a run rate of the upper or lower control limit (roughly 1.6 and 0.8, respectively).

With this, one can raise the question: what if we run better than the average? Our output would be up. How different is the effect of that situation? Well, with standard spreadsheet software, it's a simple matter to enter new values into the RRP process and — bingo! — a new RRP plan will appear showing the new picture, given the higher assumed output rate.

And, of course, it's possible to test more than one assumption at a time — and to test them together. In the example shown in CG-5, Subassembly is serving two families of product: Medium Widgets and Large Widgets.

- Let's assume it takes roughly twice as long to run a Large Widget than a Medium.
- You could test with one at the upper limit and the other at the lower limit, or any combination of the two, to see the collective consequence on the RRP.

You would then check for good or bad news in the RRP chart that gets updated based on your choices of variability.

In some Resource Requirements Planning environments, there can be more than one or two assumptions that need to be made. Keeping in mind that simplicity is good and complexity is usually not, try to limit the number of assumptions. The difficulty in testing the plan for assumption variability increases in geometric proportion to the number of assumptions being made.

However, as they say, "if you gotta, you gotta." If you have many assumptions that need to be made, you'll need many control charts to routinely validate those assumptions. Don't make it any more complex than necessary and do make it as easy to do as possible, because it needs to be done once each month.

Develop Alternative Scenarios for Resource Problems Needing Review at the Pre-Meeting (3E)

When a resource is shown to be overloaded, what options are available to rectify that condition? Well, there are many: use overtime, add people, add a shift, offload work to an alternate resource, subcontract, cut lot sizes, and many more. The issue is that the overload must be rectified; if not, then an imbalance exists between the demand for capacity and its supply — and such a plan is not producible.

If the supply of capacity cannot be increased, then the demand for it must be reduced and that typically happens via a reduction in the Operations Plan. Normally this is not a good thing because it means you will not be meeting all customers' demands.

During the prior step, Resource Requirements Planning, problems are identified. In some cases, supply people can solve a given problem on their own; in other cases, not so. This is because they are empowered to make certain kinds of decisions but not others. Here are some examples, but they are not meant to be black and white, as these kinds of things can vary widely from company to company.

- Minor decisions. Examples: add overtime, hire additional people, reduce the staff on the third shift by 10 percent. These are normally within the decision-making authority of the supply people.

- Moderate decisions. Example: add an entire shift. In most companies, this would need to be elevated to the Pre-Meeting to allow for a cross-functional view, discussion, and decision. This could then be presented in the Exec Meeting as a completed decision, as in: "We're going to add a second shift in Fabrication in Plant 4."

- Major decisions. Example: add 90,000 square feet to Plant 2, along with the necessary new production equipment. This would require significant discussion at the Pre-Meeting and one or perhaps more presentations at the Exec Meeting, prior to a decision being made by the Executive Group.

In the case of moderate or major decisions, it's often important that alternatives be explored. For example, the action to "add a shift in Fabrication in Plant 4" is one way to increase capacity. Are there other possibilities? Probably. Perhaps Plant 3 could pick up that additional work. This would result in eliminating the cost of supervision for the new shift, plus the hiring and training costs involved with the new production associates.

On the other hand, Plant 3 is in California and much of the increased volume would need to be shipped east of the Mississippi, with an attendant rise in freight costs. A third option might be to send the additional volume to a contract manufacturer, and that has its own array of costs and benefits. And a fourth alternative, unlikely in most cases, might be to not increase capacity but rather allocate the current level of output to selected customers.

These scenarios need to be presented at the subsequent step(s): the Pre-Meeting and perhaps the Exec Meeting. Obviously they need to be presented in a manner that is clear, concise, and facilitates decision making and — most important — they must carry financial information with them. This points up the need to have Finance people active in the Supply Planning step, Demand Planning, as well as the Pre-Meeting and Exec Meeting.

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FREQUENTLY ASKED QUESTIONS

If a company has aligned resources, do they need to do Resource Requirements Planning? After all, can't they just compare the Operations Plan on the S&OP spreadsheets to the capacity for the resource and see if there's an overload?

This can happen under only one set of conditions: if all of the products within all of the product families on that resource consume the same amount of resources, and if that is not expected to change. That takes the issue of mix changes off the table.

For example, if the line runs at the same speed when producing all eight SKUs within Product Family M and all 16 SKUs in Family P, then Resource Requirements Planning might be a lot simpler than we've presented here. And, of course, the resource capability check must be made regardless of how the resource requirements were derived.

In our experience, these kinds of cases are quite rare. They do reflect the principle of simplicity/complexity: the simpler the environment, then the simpler the tools needed to plan and control that environment.