Justifying Advanced Finite Capacity Planning and Scheduling

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1. Introduction

How well your manufacturing company manages production on the shop floor has a direct bearing on how well you serve your customers and how well you use the assets at your disposal. Poor execution on the shop floor can lead to decreased sales, increased cost-of-goods-sold, and increased operating expenses.

Good execution on the shop floor requires schedules that are "good" and schedules that are "flexible".

Good schedules are schedules that are both detailed and achievable. They need to explicitly consider the limited capabilities of the operation to allow people, equipment, and material to come together in the proper amounts at the proper time. Good schedules allow you to meet both your manufacturing and business goals.

Flexible scheduling allows you to investigate alternatives and adapt to changing conditions. Manufacturing is complex, random and dynamic. Flexible scheduling allows you to adjust to new order, changed orders, breakdowns, material shortages, absenteeism, and capacity problems.

For all of the benefits of good, flexible production scheduling, few manufacturers do it well. The introduction of personal computer based advanced finite capacity planning and scheduling software is helping the situation.

One such advanced finite capacity planning and scheduling software product is TACTIC. TACTIC explicitly considers capacity, shop status, and material so all schedules are detailed and achievable. TACTIC is also flexible. It features a sophisticated what-if capability, which lets you generate and choose from alternative, detailed schedules.

This paper discusses how TACTIC can help you **increase sales**, **decrease cost-of-goods-sold** and **decrease operating expenses**. It also provides a specific example of the quantitative benefits that can be expected for a typical OEM component-manufacturing firm.

2. Reducing Cost-of-Goods-Sold

TACTIC can help you reduce the following aspects of your company's cost-of-goods-sold.

2.1Direct Material Costs

2.2Direct Labor Costs

2.3Manufacturing Overhead Costs

2.1 Direct Material Costs

The lack of good scheduling makes life very difficult for your purchasing department and may increase direct material costs. The worse the schedule, the more likely it is that it will be modified. These modifications ripple back into procurement, and often result in inconsistent, highly variable material ordering patterns.

For instance, the lack of a good schedule may force the purchasing department to expedite material and, after a modification, later call the vendor to ask that delivery be delayed. Haphazard ordering costs your firm money. When you expedite your vendors, you usually incur higher costs. If you have your vendors keep a safety stock of your material, they usually charge you a higher price for the material to cover their carrying costs.

The good schedules that you can generate with TACTIC can help reduce excess material costs. Good schedules are less likely to be modified, resulting in smoother ordering. Smooth ordering may allow purchasing to take advantage of discounts and avoid premium charges.

TACTIC's what-if feature can help you hold to procurement plans and thus keep material costs low. For instance, when conditions change, TACTIC will allow you to quickly investigate the benefits of diverting material from a non-critical order to satisfy the needs of a critical order.

TACTIC also allows you to simulate shop floor changes, such as better preventive maintenance policies and different ordering practices. These, in turn, might reduce future material problems and costs.

2.2 Direct Labor Costs

A lack of good scheduling results in inefficient management of capacity, low direct labor productivity and high costs. Without a good schedule, you often produce work in a sequence that is not advantageous and sometimes you tear down jobs prematurely.

This may cause your plant to run behind schedule. When your plant runs behind schedule, you are often forced into even less advantageous sequencing and more frequent teardowns and setups. In addition, you may have to deviate from cost-effective routings or procedures. Unnecessary overtime and excess expediting related costs might be the ultimate result.

Direct labor is most productive when it is following a good, detailed, predetermined production schedule. Such a schedule allows the labor force to setup and operate efficiently. Similarly, preventive maintenance and prototype work can be efficiently scheduled.

Unanticipated shop floor changes shop floor activities can influence direct labor productivity. TACTIC can help you respond to unanticipated shop floor changes. If, for example, a machine breaks down, you might use TACTIC's what-if feature to reassign the operator and the work in the best possible manner. This may allow you to deliver a critical order without the need for overtime.

TACTIC can also help you reduce random shop floor activities. You can use TACTIC to create detailed minute-by-minute dispatch lists for each machine or member of the labor force. These lists may help reduce the random way a supervisor may assign work. This often results in the most productive use of labor and may allow some staff to be reassigned to more productive activities.

2.3 Manufacturing Overhead Costs

TACTIC can help you reduce the following components of manufacturing overhead.

2.3.1 Inventory Carrying Costs

A lack of good scheduling may lead to higher than needed inventory levels and carrying costs. For example, you may start production earlier than needed, resulting in unnecessary inventory. Work started earlier than needed can rob capacity from jobs that require it. When capacity is allocated inefficiently, lead times often lengthen. You will typically bring in material based on these artificially inflated lead times, further increasing inventory.

Without good schedules, not only do lead times lengthen, but lead time variability increases. Because jobs are scheduled haphazardly, you cannot count on having production available when you need it. As a result, you may be forced to buffer safety stock inventory.

Safety stock may also be required to protect you from inflexible scheduling. If a machine breaks down or a customer increases an order quantity, it is often possible to work around the problem with flexible scheduling. You might complete a required job by moving it off a broken down machine and onto one with additional capacity. You might satisfy an urgent customer request by splitting an order. The alternative is to carry additional safety stock.

TACTIC may help you reduce inventory. Good schedules cause work to be started when needed. Good schedules also help you better understand capacity and demand, reducing inventory due to excessive lead times.

Finally, the TACTIC what-if capability can help you reduce the need for safety stock. If changes occur, you can often reschedule production to reduce the effect of the disruption rather than holding inventory.

2.3.2 Expediting Staff

When a lack of good scheduling and unanticipated changes forces your company to be behind schedule, one alternative is to spend money to expedite to shorten lead times. Expediting gives certain work special handling so that it moves through the shop more quickly. Unfortunately, in situations when your plant is significantly behind schedule, it is difficult to tell which work should be expedited. Often, expediting time and money will be spent on the wrong work.

The good schedules that you can generate with TACTIC help improve delivery performance and reduce the need for expediting. TACTIC also helps you reduce the need for expediting with its what-if feature.

This feature will help you test your ideas before expediting on the shop floor. In this way, if you still need to expedite, TACTIC will help you do it in the most effective manner possible. Less expediting means that the people normally assigned to this task can be assigned to more productive work.

2.3.3 Schedule Generation

Under the best of circumstances, scheduling is a laborious and costly task. Typically, you have some feel for your plant's machine capacity, usually in standard hours, and some feel for the standard hours that the work to be scheduled will consume.

To schedule, you place work on machines, reducing the standard hours available as each order is scheduled. The time involved in building such a schedule means that you can try only a few alternatives. If conditions change, as they undoubtedly will, it will be difficult and time consuming to modify the schedule to reflect the change.

By using TACTIC, your staff can generate schedules more quickly than with manual methods. The result is more creative time to try out alternatives, to communicate the rationale behind decisions to others and, ultimately, to develop better schedules and policies.

When things change, TACTIC gives you the flexibility to incorporate the changes. It also gives you the ability to track performance versus plan and make adjustments before it is too late.

Finally, TACTIC may allow you to complete scheduling tasks more quickly. This may allow more time to devote to other aspects of production control.

2.3.4 Variable Overhead Costs

Variable overhead costs, such as salary for support staff, are often allocated based on direct labor. As TACTIC helps you increase your direct labor productivity, your variable manufacturing overhead costs may fall.

Increased direct labor productivity means that you can get the same production with less input. This may, for instance, mean that you can eliminate working on a Saturday. If direct labor is not working, there will be reduced need for the overhead cost of such things as supervisory personnel, electricity and supplies.

2.3.5 Out Sourcing

Often, firms resort to costly out source production when they do not have sufficient capacity to produce the work in-house. Capacity shortfalls can result from poor productivity, a lack of good scheduling, or from an inability to work around changes, like machine breakdowns, that effect capacity.

The increased productivity that TACTIC can help you achieve often means more available capacity. TACTIC can also help you handle changes. The result is more efficient management of capacity.

Better capacity management, in turn, may help you reduce the need for out sourcing. If you can make out sourced products more cheaply than you can buy them, significant cost savings may result.

2.3.6 Quality Costs

When your plant is behind schedule, due to a lack of good scheduling and unanticipated changes, and hurrying to meet customer demands, inevitably short cuts are taken. You might be forced to eliminate operations or follow a nonstandard routing. This often results in scrap and rework costs.

You can help cut these costs through using TACTIC to generate good schedules. Also, when quality problems do occur, TACTIC's what-if flexibility can help you generate schedules that reduce the effect of these problems.

2.3.7 Maintenance Costs

Most firms are willing to bear the cost of a maintenance department to help ensure greater machine availability. However, the lack of good scheduling and the lack of ability to react to shop changes may be forcing your maintenance department to operate in a reactive mode. If this is the case, you may not be getting full maintenance benefits and you may be incurring unneeded maintenance costs.

A well-planned and well-executed preventive maintenance program is essential to ensuring high levels of machine up time. Unfortunately, when a machine is undergoing preventive maintenance, it is not producing product. Therefore, most manufacturers find themselves in a dilemma. If preventive maintenance is done, machine time is unavailable for today's hot job. If preventive maintenance is put off, machines break down much more frequently, usually when they are running tomorrow's hot jobs.

Too often, manufacturers defer maintenance. This results in frequent, unexpected machine breakdowns that hurt manufacturing productivity. These breakdowns also force the maintenance department to run from one breakdown to another in a reactive, high cost manner.

The solution is to develop good production schedules that balance the tradeoffs associated with meeting both production and maintenance needs. You can use TACTIC to coordinate maintenance schedules with production schedules leading to greater machine up time, more efficient use of maintenance resources and thus lower costs. When machines do unexpectedly break down, you can use the TACTIC what-if feature to see the tradeoffs of different repair strategies.

3. Reducing Operating Expenses

TACTIC can help you reduce the following aspects of your company's administrative and operating expenses.

3.1 Finished Goods Carrying Costs

You may be forced to hold excess finished product as safety stock and incur unneeded cost. This safety stock is often required because of variability in lead times, brought on by the lack of good scheduling and the inability to react quickly to changing conditions. TACTIC can help you generate the good schedules that will help you predict when orders will be completed. It can also help you react to changing conditions, reducing the need for safety stock.

3.2 Premium Transportation Costs

When your plant is behind schedule and when you have trouble reacting to changing conditions, costly shipping methods may be required to shorten lead times and get product to customers. The good schedules that you can create with TACTIC, and its use to better react to changes, help you make delivery promises that you can keep. If you operate in a make to order environment, better delivery promises mean less need to save time through costly shipping methods.

3.3 Back Order Costs

If you operate in a make to stock environment, back order costs are more prevalent than premium transportation. The good schedules that you can create with TACTIC and its ability to react to changing conditions mean greater product availability and lower back order costs.

3.4 Purchasing Costs

The lack of good schedules and unanticipated changes forces the purchasing department to continually expedite vendors. Not only do these constantly fluctuating order patterns result in higher material costs, but they increase the costs associated with operating the purchasing department. The ability to use TACTIC to generate good schedules, and to help react to changes, results in smoother ordering practices. This means purchasing can be more efficient, thus reducing administrative costs.

3.5 Engineering Costs

Just as the maintenance department needs access to production equipment to do the preventive maintenance that will increase tomorrow's profits, engineering needs access to the same equipment to build prototypes. The lack of a good schedule and ability to react to changes increases prototyping costs. If prototyping is deferred, your long-term competitive position may be damaged.

The ability of TACTIC to help you generate good production schedules allows prototype work to be better coordinated with regular production. Its what-if feature helps you react quickly to changing conditions and allows rush prototyping jobs to be effectively handled. This capability allows the engineering staff to produce prototypes efficiently; reducing engineering costs and helping to ensure a long-range stream of new products.

3.6 Capital Expenditures

A lack of good scheduling results in poor productivity and improper management of existing capacity. This can cause low utilization of existing capital equipment. Firms often attempt to solve their capacity problems by purchasing new capital equipment.

TACTIC can help you develop better schedules that may help you obtain higher machine utilization and thus more production from your existing equipment. Higher machine productivity may allow you to delay or cancel planned capital purchases.

Also, TACTIC gives you the flexibility to try different what-if ideas. These ideas may enable you to development more efficient procedures that further reduce the need for capital expenditures.

4. Increasing Sales

TACTIC can help you improve the following aspects of sales performance. These improvements may help you deliver a higher quality product in a timelier manner and thus help increase sales.

4.1 Customer Service

The lack of good scheduling makes it impossible to accurately predict when product will be available. Fluctuating product availability prevents you from making realistic delivery promises to your customers. Changes, such as increased customer orders, also make it difficult to predict delivery.

TACTIC can help you generate better schedules and efficiently communicate those schedules to your Customer Service, Sales and Marketing Departments. When situations change, TACTIC gives you the flexibility to schedule around the changes or to predict the impact of changes on delivery.

If you operate in a make to order environment, Customer Service can make more realistic promises to your customers. If you operate in a make to stock environment, Sales and Marketing can count on increased availability of product.

Under either scenario, TACTIC can help you better service your customer's delivery needs. This may also provide an advantage over your competition, increase market share and increase sales volume.

4.2 Lead Times

The lack of good schedules and the inability to react to shop floor and other changes results in lengthened lead times. The good schedules that you can create with TACTIC and its flexibility to help you work around problems can help shorten lead times. The ability to deliver more quickly may help you gain a competitive advantage, which may, in turn, help you win new sales and increase sales revenues.

4.3 Warranty Claims

The lack of good schedules and ability to react to changes may result in production of poor quality work. Inevitably, some of this work will reach your customers, resulting in warranty claims and the associated customer dissatisfaction.

The increase in quality that you can obtain by creating good schedules using TACTIC and the ability to react to changes may result in less defective products reaching your customer. Less defective product may lead to reduced warranty claims, increased sales and greater market share.

5. Profitability Example

The increase in profitability that you can expect from using TACTIC due to cost-of-goods-sold decreases, operating expense decreases and sales increases can be significant. Pay back can be measured in months for a typical manufacturing firm.

The exact amount of increased profitability will, of course, depend on the size and nature of your business. Success in relating profitability increases directly to TACTIC will also depend on your company's accounting systems. In certain cases, some benefits may be difficult to quantify.

The following example lists some rough measures of the benefits of using TACTIC. The example company, Quality Manufacturing, has sales of $25,000,000. The company produces components for the automotive industry. For most manufacturing firms, Cost-of-Goods-Sold might be anywhere from 50% - 80% of the sales price of their products. For Quality Manufacturing, Cost-of-Goods-Sold is 70% of sales or $17,500,000.

Quality Manufacturing's Cost-of-Goods-Sold consists of: 37% direct materials ($6,475,000); 8% direct labor ($1,400,000); 55% manufacturing overhead ($9,625,000). This breakdown is typical of most firms in its industry.

5.1 Direct Material Costs

TACTIC can lead to material cost savings of at least 0.5% due to more efficient ordering. These savings would occur yearly. Quality Manufacturing has material costs of 37% of Cost-of-Goods-Sold. The yearly savings from TACTIC would therefore be $32,375 ($17,500,000 *0.37*0.005).

5.2 Direct Labor Costs

TACTIC can yield direct labor productivity increases of 5 to 10%. Savings are calculated based on the number of hours saved times the burdened labor rate. If overtime is being used, savings would reflect this rate. These savings would occur yearly.

Quality Manufacturing's yearly direct labor costs are $1,400,000. It pays an average hourly labor rate of $15 per hour plus 20% for benefits ($18 per hour).

At $18 per hour, a 5% productivity increase results in 3,888 ((1,400,000/18)*0.05) more standard hours available. Quality Manufacturing is using half of this productivity gain to reduce time and a half overtime for a savings of $49,572 (($18+7.5)*3,888*0.5). The other half of the gain is used to reduce out sourcing.

5.3 Inventory Carrying Costs

Most firms turn their inventory 5 to 10 times per year. The cost of carrying inventory is 20 - 25% of the value of the inventory. TACTIC can help reduce inventory by 2-5% or more. These savings would occur yearly.

Quality Manufacturing has an inventory carrying cost of 20% and turns its inventory 8 times per year. This means that it has an average inventory carrying cost of $437,500 ($17,500,00/8*0.20). A 2% inventory reduction would result in annual savings of $8.750 ($437,500*0.02).

5.4 Personnel Involved in Expediting

Expediting savings depend on how the firm is organized. Quality Manufacturing has one expeditor, paid $12 per hour, including benefits. TACTIC has caused this expeditor to be reassigned for a yearly savings of $24,000 ($12*2000 hours).

5.5 Generation of Schedules

TACTIC can help increase scheduling productivity. Productivity gains of 15% are reasonable. These savings would occur yearly.

Quality Manufacturing has one person, paid $36,000 per year, involved in scheduling. TACTIC has caused this scheduler to be assigned additional tasks. Therefore, a 15% productivity gain would lead to an annual cost savings of $5,400 ($36,000*.15).

5.6 Variable Overhead Costs

Thirty percent of a firms manufacturing overhead might be variable. Most firms allocate overhead based on direct labor. Therefore, a 10% reduction in direct labor hours due to increased productivity would lead to a 3% decrease in variable overhead. These savings would occur yearly.

Due to increased labor productivity, Quality Manufacturing was able to cut hours worked 2.5%. Therefore, based on overhead costs of $9,625,000, an annual savings in overhead costs of $72,187 ($9,625,000 *0.3*0.025) was achieved.

5.7 Out Sourcing Costs

Savings would depend on the amount of parts that a firm could bring back in-house. Quality Manufacturing is out sourcing the manufacture of a part it sells for $100.

It could make the part in house for $70, but due to a capacity problem, it is forced to buy the part in significant quantities for $90. It takes 0.33 standard hours of direct labor to make the part.

Quality Manufacturing wants to use half of the 3,888 standard hours made available through TACTIC productivity increases to make this part. Quality Manufacturing can therefore bring 5890 ((3,888*.5)/0.33) of these parts back in-house. At a cost savings of $20 per part, Quality Manufacturing can save $117,800 ($20* 5,890) annually.

5.8 Cost of Quality

The cost of quality, including the cost of inspection, scrap, rework, warranty costs and quality control staff, can be up to 20% of the firm's total direct labor and manufacturing overhead costs.

Due to better scheduling, TACTIC can reduce these costs 0.5%. These savings would occur yearly. For Quality Manufacturing, this results in savings of $11,025 ((1,400,000+9,625,000)*0.2*.005).

5.9 Maintenance Costs

Due to better coordination and scheduling of preventive maintenance, TACTIC can improve the productivity of maintenance personnel 2.5%. These savings would occur annually.

Quality Manufacturing has three maintenance staff, paid $18 per hour. It obtained a 2.5% productivity increase and use these extra hours productively. This results in savings of $2,700 (3*$18* 2000*0.025).

5.10 Premium Transportation Costs

Premium transportation expenses of around 1% of sales are not uncommon in make to order industries such as automotive. TACTIC can help reduce these expenses 10%. These savings would occur yearly.

Quality Manufacturing has a premium transportation expense of 0.75% of sales or $187,500 ($25,000,000* .0075). A 10% reduction yields an annual savings of $18,750 ($187,500*.1).

5.11 Back Order Costs

For a make to stock firm, with many orders, back order costs can be significant. The company needs to generate a back order notice to the customer, hold the back order, and check regularly to see if the back order can be satisfied.

This cost can be significant depending on order volume. However, since Quality Manufacturing is a make to order firm, the back order cost is not significant.

5.12 Purchasing Costs

The administrative savings in purchasing due to better scheduling with TACTIC can average 2%, exclusive of material costs. These savings would occur yearly.

Quality Manufacturing has one person in purchasing and he has an annual budget of $50,000. A 2% cost savings will yield an average annual savings of $1,000 ($50,000*.02).

5.13 Engineering Costs

TACTIC can help the Engineering Department save administrative and scheduling costs related to using production equipment to prototype parts. Savings of 10% are reasonable. These prototype part savings would occur yearly.

Quality Manufacturing has an engineer who is paid $55,000. He spends 20% of his time involved in producing prototypes. Due to TACTIC, he is 10% more productive for an annual savings of $1,100 ($55,000*0.2* 0.1), assuming he can be assigned to other projects.

5.14 Lower Capital Costs

Due to better scheduling and the ability to try out different procedural alternatives, TACTIC can help use existing capital equipment better, reducing the need for capital purchases.

TACTIC helped Quality Manufacturing alleviate a capacity constraint, and allowed the company to save the $100,000 it had intended to spend on new equipment. This is a one time saving.

5.15 Sales

As TACTIC helps companies improve customer service, decrease lead-time, and provide higher quality products, they often see their sales increase. A 1% or greater increase in sales is not unusual. However, for competitive marketplaces, sales increases usually draw attention and as a result the do not last very long as competitors find ways to catch up.

Due to using TACTIC, Quality Manufacturing has experienced a one time sales increase of $250,000, or 1% of sales. At a gross margin of 70%, this will yield a profit increase of $75,000 ($250,000*.3).

6. Summary

For Quality Manufacturing, TACTIC helped achieve the following annual cost savings due to decreases in cost-of-goods-sold and decreases in operating expenses. It also helped Quality Manufacturing achieve one-time profit improvements. These improvements were due to improved sales and cost avoidance.

6.1 Annual Cost Savings

6.1.1 Cost-of-Goods-Sold Savings

Direct Material	32,375
Direct Labor	49,572
Inventory Carrying	8,750
Expediting	24,000
Scheduling	5,400
Overhead	72,187
Out Sourcing	117,800
Quality	11,025
Maintenance	2,700
Total Cost-of-Goods-Sold Savings	$323,809

6.1.2 Operating Expense Savings

Transportation & Back Order	18,750
Purchasing	1,000
Engineering	1,100
Total Operating Expense Savings	$20,850

6.1.3 Total Savings

Total Annual Cost Savings	$344,659

6.2 One Time Profit Improvements

6.2.1 Capital Cost Avoidance

Total Cost Avoidance Savings	$100,000

6.2.2 Sales Profit Increase

Total Sales Profit Increase	$75,000

6.2.3 Total Profits

Total Profit Increase	$175,000

About the Author

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More Information

This Paper was presented at the Scientific Computing Conference. It is being provided with compliments from Waterloo Manufacturing Software. For more information about Waterloo Manufacturing Software's advanced finite capacity planning and scheduling system, TACTIC, or Mr. Murgiano's other papers, contact:

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