SOLVING DAM PROBLEMS

Reject Cost Accounting's Answer and Build Jobs That Make the Most Money

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SUMMARY

Cost accounting selects jobs with the highest margin and rejects jobs with the lowest margin, but this may be the wrong answer; the highest margin jobs may not be the most profitable! The problem is that cost accounting ignores flow—the rate of money generated per unit time. Understanding how to optimize constraint can generate impressive top and bottom line performance.

Picture this scene. The plant manager comes storming into his office, upset from the quality meeting where the scrap rate has inexplicably increased. He thinks, "Are my managers, engineers, and workers out to get me fired?" He then checks his messages. The corporate controller says, "Your plant lost over $85,000 this month." Then he listens to his boss's message, "What is wrong with you and your incompetent team? Do I need to find somebody else for your job!? Call me immediately and explain how you're going to fix this!"

Frustrated, the plant manager looks at his numbers from the printed report in front of him. He sees that the average panel price increased to more than $800 per panel. The cost per panel exploded to over $900. How could the breakeven point change so dramatically? Accounting has to be wrong! He knows his boss is expecting him to fire people in order to "fix this." Trying to remember happier times, he looks at the picture of his wife and kids on the credenza.

This problem is of the type that Eliyahu Goldratt (author of *The Goal and The Theory of Constraints*) claims 99 out of 100 business managers get wrong. In *Factory Physics,* authors Hopp and Spearman provide the prototype example. Let's say you have two products, A & B, and they sell for the same price. Each product requires the exact same amount of time to make so labor costs are identical. The only difference from an accounting perspective is that product B requires more expensive material. No matter what accounting scheme you come up with it will tell you to make as much A as you can and you would be wrong. Why? Cost accounting never deals with dollars per unit time—or flow.

A flow is limited by the slowest step or what is commonly called the constraint. For example, nobody can move faster than the slowest person when everyone is tied to a rope. In the Hopp and Spearman example, one machine acts as the constraint—which sets the takt time (cycle time) for the factory. Product A is $550 per and product B is $500 per part over the cost of material. It takes 2 hours for product A and 1.5 hours for product B to get through the constraint. Product A generates $275/hr and product B generates $333/hr. When you look at flow, or dollars per unit time, you want to produce as much B as possible, not A! Cost accounting is the wrong tool to use to optimize a complex manufacturing system.

Let's pretend we are assigned to help the plant manager, who draws up Table 1 on the white board. This shows what shipped in terms

	Shipped	Profit	Price	Material	Mix
Job 1	701	$700.00	$900.00	$200.00	82%
Job 2	0	$450.00	$600.00	$150.00	0%
Job 3	150	$100.00	$400.00	$300.00	18%
Panels Shipped	851				

Table 1.

	Scrap Rate	Starts
Job 1	25%	876
Job 2	10%	-
Job 3	70%	255

Table 2.

ET Test Area	Test Times
Job 1 (min; by lot)	300
Job 2(min)	100
Job 3(min)	550

Table 4.

of Job 1, 2 and 3 over the last month. Job 2 was dropped because it didn't have sufficient margin according to the cost accounting department.

The profit per job shown in the table is just the price paid minus the material costs. The plant manager regards labor and overhead allocations as hocus-pocus since the same base monthly expense rarely changes. He explains to you the huge amount of meaningless detail the cost accounting department throws at him. In order to deal with the immediate needs of his plant, he explains to you his simple and powerful way of accounting for the money.

He explains why his plant should have made money based on average panel price and average panel cost. For example, by making more of Job 1, the average panel price would go up and at the same time, the average panel cost should stay fixed. He says, "No matter how difficult the job I fully expect my people to make the numbers, no matter what. Operations are like war and in war people are expected to do great things and prevail against all odds." The stress lines on his face are obvious. He further explains his frustration with Job 3, which is a job the corporate office requires to be made for another division in the company. He believes he is being screwed because of the bad board design and the low transfer price.

You draw up Table 2 on the white board as he spits out the yields as well as the production starts for each job.

You ask him what the constraint is for the factory. After a few minutes it sounds like it could be the laser area or the electrical test area. You understand the math will uncover the true constraint. Table 3 shows the laser time by job to produce a lot worth of boards—10 panels.

The calculators come out. In a month with 21 work days and two 8-hour shifts there were 20,160 minutes of available production time. Since there are three identical laser machines, the total laser capacity for the month was 60,480 minutes. There were 55,748 minutes of laser time consumed, leaving a slack capacity of 4,733 minutes. Laser was not the constraint.

Table 4 shows the electrical test times by lot.

There are two identical electrical test machines. That means there were 40,320 available minutes for the month. With only 15 minutes of slack left, this was the constraint.

The result that the plant manager can't comprehend is given below in Table 5. The profit is calculated using the plant manager's simple formula of price paid over material cost, minus cost of material scrapped, minus monthly aggregate expenses.

$700(701) + $100(150) - $200(175)
- $300(105) - $25,000 x 21 = -$85,800

Laser Area	Total	Final Route	Holes	Vias
Job 1 (min; by lot)	600	450	100	50
Job 2 (min)	250	100	100	50
Job 3(min)	125	75	50	0

Table 3.

Results: Max Panel Price	
Revenue	$690,900
Costs	$776,700
Profit (Loss)	$(85,800)
GPM	-12%
Average Panel Cost	$912.69
Average Panel Price	$811.87
Average Yield	67%
Takt Time (min)	23.7
Dollars/Min	$(4.25)

Table 5.

Results: Max Profit Equation	
Revenue	$1,089,000
Costs	$885,255
Profit	$203,775
GPM	19%
Average Panel Cost	$516.17
Average Panel Price	$634.99
Average Yield	82%
Takt Time (min)	11.8
Dollars/Min	$10.11

Table 6.

The plant manager stares at this table. It's tempting to support the notion that the workers are incompetent and lazy. You help the plant manager prepare a spreadsheet. You explain how you can use linear programming (LP) within the spreadsheet. You enter the constraints where Job 1 demand must be 300 panels shipped and Job 3 demand must have 150 panels shipped. The total amount of laser time cannot exceed 60,480 minutes and the total amount of electrical test time cannot exceed 40,320 minutes. The LP result is shown in table 6.

This is a much better result than table 5! Table 7 shows the production plan required to get the results in Table 6. You and the plant manager check the math by plugging the results into the profit equation.

$700(300) + $450(1,265) + $100(150)
- $200(75) - $150(127) - $300(105)
- $25,000 x 21 = $203,700

In this situation, all of the laser time has been used, meaning it is the constraint. You explain that Job 1 is generating $11.66/min; Job 2 is generating $18/min; Job 3 is generating $8/min. In order to maximize profitability you want to produce and sell as much of Job 2 as you can. The plant manager realizes trying to maximize the average panel price was the wrong thing to do. He calls up his sales manager. He wants to be able to tell his boss that by bringing Job 2 back, he can deliver profitable performance. He knows this will meet with serious resistance.

In Akio Morita's, Made in Japan, the author

	Shipped	Starts	Mix
Job 1	300	380	17%
Job 2	1,265	1,392	74%
Job 3	150	260	9%
Panels Shipped	1,720		

Table 7.

Creep Corrosion Prevention

by Real Time with...SMTAI 2011

Semblant CTO Tim Von Werne discusses his SMTAI paper on preventing creep corrosion with plasma-deposited fluoropolymer.

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talks about handling a request for quotation during Sony's early days, where Morita was the cofounder. At the time, he knew his plant's capacity was 10,000 radios per month. He was to quote prices from 5, 10, 30 and 100 thousand radios per month. He quoted high prices on the 30 and 100 thousand radio volumes! This was because of the capital costs of expanding capacity beyond 10,000 radios per month, as well as the human costs. He didn't want to hire a bunch of people, and when the job was done, fire a bunch of people! His choice was met with resistance at Sony and with the distributor. However, it was the right choice.

A sales force has significant incentives for going after the most highly priced jobs. Manufacturing is pressured to say yes to these jobs. Plant managers are expected to push people beyond their limits to ship these jobs. This view will kill our industry in this country. When we understand how to optimize our constraints we can generate impressive top line and bottom line performance without all of the pressure and stress.

My friend, Tarun Amla, turned a plant that was about to be closed down into a cash-printing machine! He optimized the produce mix for profitability using a LP model. The focus shifted from making so-called "high margin," but resource constrained products, to products that made the most money. Many people think this flow-way of thinking where you have to factor in the constraints is counter intuitive. If you think about it, it's really common sense.

Download the spreadsheet used for this example and a video that walks you through the example here. **PCB**

Gray McQuarrie is the President of Grayrock & Associates, a team of experts dedicated to building collaborative team environments that make companies maximally effective. McQuarrie is the primary inventor of the patent Compensation Model and Registration Simulation Apparatus for Manufacturing Printed Circuit Boards. He has worked for AlliedSignal, Shipley, Photocircuits, Monsanto and many other companies and clients. For more information, visit www.grayrock.net, or email McQuarrie at gray@grayrock.net.