Theory of constraints will really improve your competitiveness

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Abstract

The Theory of Constraints (TOC) is a new management philosophy created by Eliyahu M. Goldratt to help an enterprise reach its goal. To accomplish this objective a company must change the paradigm of costs and follow two fundamental techniques: the five focussing steps and the thinking process. In this second article we present the "cost world" and the TOC solutions to this problem.

Sinopsis

La Teoría de Restricciones (TOC, por sus siglas en inglés) es una filosofía gerencial desarrollada por Eliyahu M. Goldratt con el objetivo principal de ayudar una empresa a alcanzar su meta. Para lograr este objetivo la teoría establece la necesidad de cambiar el paradigma de costos y el uso de dos técnicas fundamentales: los cinco pasos de optimización ("five focussing steps") y el proceso decisional ("thinking process"). En este segundo artículo presentamos el aspecto de los costos y las soluciones que ofrece la Teoría de Restricciones.

The "cost world" solution

Under the "cost world " approach we may find two different solutions depending on the capacity awareness of the analyst.

1. **No capacity awareness at all**

Under this conditions the solution is obtained as follows:
Total income:

P-	$90/unit x 100 units =	$ 9,000	(1)
Q-	$100/unit x 50 units =	5,000	(2)
		$14,000	

Costs:

Raw material

P-	$45/unit x 100 units =	$ 4,500	(3)
Q-	$40/unit x 50 units =	2,000	(4)
		$ 6,500	

Operating expense	6,000	
	$12,500	
Profits ($14,000 - $12,500)	$ 1,500/wk	(5)

Obviously, this solution is totally wrong because it does not consider the limitations imposed by the production capacity available. It assumes that all units of both products can be manufactured, an assumption which in this case is impossible. Those who take this path will expect $1,500 weekly profits and will see their expectations disappear when they try to manufacture all units of products P and Q.

2. **Capacity awareness**

Those who are aware of production capacity limitations understand that they must find out whether they can manufacture all units of both products. If they can not, then they must carry out a profitability analysis to decide which product is better for the company. Those who still work under the "cost world" paradigm will proceed as follows.

A. Determine whether all units of both products can be manufactured by using available company resources.

In this case we multiply the time required by each unit at each resource by the total number of units to be produced weekly. Table 1 shows these results.

Table 1. Scenario if we produce all units of both products
Sales P:100 units, Q:50 units

		Resource A		Resource B		Resource C		Resorce D
	Cycle	Required	Cycle	Required	Cycle	Required	Cycle	Required
P	15	1500	15	1500	15	1500	15	1500
Q	10	500	30	1500	5	250	5	250
Totals		2000		3000		1750		1750
Available	1	2400	1	2400	1	2400	1	2400

It is obvious that resource B will not be able to meet all the demand since it requires 3,000 minutes a week and it has only 2,400 minutes available. Therefore we have to find the most profitable product combination for the company.

B. Determination of the most profitable product combination

To determine the most profitable product combination under the "cost world" paradigm, we may follow one of the following approaches: marketing, cost accounting and the theory of constraints solution. All of these approaches consider what cost accounting calls product "unit cost."

1. Marketing approach

Sales personnel normally receive a percentage of the total sales. If we look at the sales price for each product, P sells for $90/unit and Q sells for $100/unit. Therefore, sales people will earn more money if they push the sales of product Q. Thus, according to the marketing approach, Q is the better product and we will try to sell all 50 units of Q and whatever we can sell of product P.

2. Cost accounting approach

Under the cost accounting approach we decide which product has the higher profit margin. The product margin is the difference between the product sales price and its "unit cost". In our particular example, we proceed as follows:

Product P			
	Raw material		$45.00/unit
	Overhead	[(6000/8500)x6,000/100][1]	42.35/unit
	Total		$87.35/unit
	Profit margin	($90.00 - $87.35)	$ 2.65/unit (6)
Product Q			
	Raw material		$40.00/unit
	Overhead	[(2500/8500)x6,000/50]	35.29/unit
	Total		$75.29/unit
	Profit margin	($100.00 - $75.29)	$ 24.21/unit (7)

[1] Overhead assignment is based on the percentage of total time required to manufacture all units of P and Q; 60 minutes per unit for P times 100 units is 6,000 minutes, and 50 minutes per unit of Q times 50 units is 2,500 minutes for a total of 8,500 minutes. Of those 8,500 total minutes the fraction corresponding to P is 6,000 minutes divided by 8,500 minutes. The same procedure is applied to product Q.

Again, Q is more profitable than P. Therefore, we prefer to push for the sale of product Q rather than product P.

To determine our profits under the "cost world" approach we must decide how many units of Q and P we can manufacture. Since Q is our better product, we try to manufacture all of its 50 units. Given that resource B is the limiting element in the manufacturing facility, we calculate how many minutes it will take to produce all 50 units of Q at this resource:

$$30 \text{ min/unit} \times 50 \text{ units/wk} = 1{,}500 \text{ min/wk} \quad (8)$$

This leaves 900 minutes of resource B free to be used for product P. Therefore, we can manufacture 60 units / week of product P.

$$900 \text{ min/wk} \div 15 \text{ min/unit} = 60 \text{ units/wk} \quad (9)$$

Now we calculate our sales revenues, weekly costs, and weekly profits:

Sales revenues		
Q: \$100/unit x 50 units/wk =	\$ 5,000/wk	(10)
P: 90/unit x 60 units/wk =	5,400/wk	(11)
	\$10,400/wk	
Total costs		
Raw material		
Q: \$40/unit x 50 units/wk =	\$ 2,000/wk	(12)
P: 45/unit x 60 units/wk =	2,700/wk	(13)
	\$ 4,700/wk	
Overhead	6,000/wk	
	\$10,700/wk	
Profits	(\$300/wk)	

We are losing money. How come? Our analysis showed that we were going to make money on each unit we could sell. What happened? Cost accounting happened. The concept of unit cost is misleading. It is based on a number of invalid assumptions resulting in wrong decisions.

3. The TOC approach

The TOC approach uses the five focussing steps to decide what should be done.

A. Identify the constraint

To identify the constraint we must determine the total time required to manufacture all units of each product at each resource. To accomplish this, we multiply the time per unit at the resource by the total number of units per week. These results are shown in table 1 and the constraint is identified as resource B.

B. Exploit the constraint

We want to make the best use of the constraint. Since we cannot manufacture all units of both products, we must find out which one is more profitable at the constraint. Therefore, we must forget about "cost accounting" and "unit cost" and consider the profit to be the difference between the sales price and the raw materials cost. For product P the profit is \$45/unit (\$90/unit - \$45/unit) and for product Q the profit is \$60/unit (\$100/unit - \$40/unit).

Then we determine, for each product, the profit per minute obtained by the company at the constraint. Product P yields a profit of \$3/minute with 15 minutes at constraint and product Q results in a \$2/minute profit with 30 minutes at constraint. This means that every minute of the constraint used to manufacture product P contributes \$3 to the company, whereas every minute used for product Q contributes only \$2. Obviously, product P is

more profitable than product Q.

Next we must determine how many units of P and Q we can manufacture. Since P is our better product, we will try to manufacture the 100 units. Given that resource B is the limiting element in the manufacturing facility, we calculate how long it will take to produce the 100 units of P at this resource:

$$15 \text{ min/unit} \times 100 \text{ units/wk} = 1{,}500 \text{ min/wk} \quad (14)$$

This leaves 900 minutes of resource B free to be used for product Q, Thus we can manufacture 30 units/week.

$$900 \text{ min/wk} \div 30 \text{ min/unit} = 30 \text{ units/wk} \quad (15)$$

Now we can calculate our sales revenues, weekly costs, and weekly profits:

Sales revenues			
P:	\$ 90/unit x 100 units/wk =	\$ 9,000/wk	(16)
Q:	100/unit x 30 units/wk =	3,000/wk	(17)
		\$12,000/wk	
Total costs			
Raw material			
P:	\$45/unit x 100 units/wk =	\$ 4,500/wk	(18)
Q:	40/unit x 30 units/wk =	1,200/wk	(19)
		\$ 4,700/wk	
Overhead		6,000/wk	
		\$10,700/wk	
Profits		\$300/wk	

Now we are making money.