THROUGHPUT ACCOUNTING AND THE THEORY OF CONSTRAINTS, PART 1

A member of the Paper F5 examining team shares her latest read and how it changed her views on throughput accounting and the theory of constraints

I've just finished reading a book. It was the type of book that you pick up and you cannot put down (other than to perform the mandatory tasks that running a house and looking after a family entail!) Even the much-awaited new series of one of my favourite television programmes couldn't tempt me away from my book.

Now obviously I'm telling you this for a reason. I love reading and it's not unusual to find me glued to a book for several days, if it's a good one. But you've gathered by now that the book I've been reading was not the usual Man Booker or Orange prize fiction novel that you might ordinarily find tucked away in my handbag. It was in fact *The Goal: A Process of Ongoing Improvement* by Eli Goldratt and Jeff Cox. If by now you've settled quickly into the belief that I must conform to society's expectations of your typical 'number crunching' accountant of which – by the way – I've met few in reality, you are wrong. So what then, you may ask, makes this book so different from the image that the title conjures up? Let me tell you all about it.

The Goal, originally published back in 1984, presents the theory of constraints and throughput accounting within the context of a novel. It tells the story of Alex Rogo, a plant manager at a fictional manufacturing company called UniCo, which is facing imminent closure unless Alex can turn the loss-making plant into a profitable one within three months. In his attempt to do so, Alex is forced to question the whole belief in the US at the time that success in manufacturing is represented by a 100% efficient factory (ie everyone and every machine is busy 100% of the time), which keeps cost per unit as low as possible.

To be honest, before I read the book, I wasn't really convinced about throughput accounting – although the theory of constraints has always made perfect sense to me. But, having read about both in the context of a very believable plant that was representative of many at the time, my views have changed. It's easy to stand in a classroom and lecture about throughput accounting and criticise it for being 'nothing new', but what we have to remember is, back in 1984, this was new, and for those companies that adopted it, it made a huge difference.

I'm aware that, if I want you to share my renewed interest in throughput accounting, I need to tell you more about the story that gripped me. If I don't do this, you'll just go away having read yet another article about throughput accounting, and any doubts that you have about its relevance today will remain the same. On the other hand, I'm also aware that, when sitting professional exams, you need to have a working knowledge of throughput accounting that you can apply in the exam hall.

Consequently, I've decided that, in this first article, I'll summarise the story contained in The Goal, bringing out some of the basic principles of the theory of constraints and throughput accounting. Then, in the second article, I'll talk you through a practical approach to questions on throughput accounting.

THE IMPORTANCE OF CONSIDERING AN ORGANISATION'S GOAL

Alex Rogo's journey begins with a chance meeting with his old physics teacher, Jonah, at an airport, after attending a conference about robotics. This is just before Alex finds out about the threat of closure at the plant. The UniCo factory has been using robotic machines for some time now and Alex is proudly telling Jonah about the improvements in efficiency at the factory. Jonah is quick to question whether these improvements in efficiency have actually led to an improvement in profits. Alex is confused by the way the conversation is going. This confusion is reflective of the US thinking at the time. There is so much focus on efficiency and reducing labour costs with increased automation, but without consideration of whether either of these things are having any impact on profit. In the case of UniCo – and indeed many other real factories at the time – the so-called improvements in efficiency are not leading to increased profits. In fact, they seem to be leading to losses.

Jonah leads Alex to consider what the goal of UniCo really is. Until this point, he – like his superiors at Head Office – has just assumed that if the factory is producing increasingly more parts at a lower unit cost, it is increasingly efficient and therefore must be doing well. All the performance criteria that the business is using support this view; all Alex's bosses are concerned about seems to be cost efficiencies.

After some reflection, Alex realises that the overriding goal of an organisation is to make money. Just because a factory is making more parts does not mean to say that it is making more money. In fact, UniCo shows that just the opposite is happening. The plant has become seemingly more efficient, thanks to the use of the robots, but the fact is that inventory levels are huge and the plant is constantly failing to meet order deadlines. It is standard practice for orders to be five or six months late. An order at the plant only ever seems to go out when one of the customers loses patience and complains loudly, resulting in the order being expedited – ie all other work is put on hold in order to get the one order out. Customers are becoming increasingly dissatisfied, losses are growing, and crisis point is reached.

Clearly, the 'goal' that the objective of the plant is to make money needs to be more clearly defined, in order to generate improvements, and Jonah helps Alex do this by explaining that it will be achieved by 'increasing throughput whilst simultaneously reducing inventory and operational expense'. Some definitions are given at this point:

- 'throughput' is the rate at which the system generates money through sales
- 'inventory' is all the money that the system has invested in purchasing things that it intends to sell
- 'operational expense' is all the money that the system spends in order to turn inventory into throughput

WORKING OUT HOW TO ACHIEVE THE GOAL

Having worked out what the goal is, Alex is then left with the difficult task of working out how that goal can be achieved. The answer begins to present itself to Alex when he takes his son and some other boys on a 10-mile hike. Given that the average boy walks at two miles an hour, Alex expects to reach the halfway point on the hike after about two and a half hours of walking. When this doesn't happen, and Alex finds that the group is behind schedule and big gaps are appearing between them, he begins to question what is going on. He soon realises that the problem is arising because one of the boys is much slower than the others. This boy is preventing the other boys from going faster and Alex realises that, if everyone is to stay in one group as they must, the group can only go as fast as their slowest walker. The slow walker is effectively a bottleneck: the factor that prevents the group from going faster. It doesn't matter how fast the quickest walker is; he cannot make up for the fact that the slowest walker is really slow. While the average speed may be two miles per hour, the boys can all only really walk at the speed of the slowest boy.

However, Alex also realises that they can increase the boy's speed by sharing out the heavy load he is carrying in his bag, enabling him to walk faster. In this way, they can 'elevate the bottleneck' – ie increase the capacity of the critical resource. Alex cannot wait to get back and identify where the bottlenecks are happening in his factory and find out if they can be elevated in any way, without laying out any capital expenditure.

STATISTICAL FLUCTUATIONS AND DEPENDENT EVENTS

The other thing that Alex gains a better understanding of on the hike is the relationship between dependent events and statistical fluctuations. Jonah has already explained to Alex that the belief that a balanced plant is an efficient plant is a flawed belief. In a balanced plant, the capacity of each and every resource is balanced exactly with the demand from the market. In the 1980s, it was deemed to be ideal because, at the time, manufacturing managers in the Western world believed that, if they had spare capacity, they were wasting money. Therefore, they tried to trim capacity wherever they could, so that no resource was idle and everybody always had something to work on. However, as Jonah explains, when capacity is trimmed exactly to marketing demand, throughput goes down and inventory goes up. Since inventory goes up, the cost of carrying it – ie operational expense also goes up. These things happen because of the combination of two phenomena: dependent events and statistical fluctuations.

The fact that one boy walks at three miles an hour and one boy walks at one mile an hour on the hike is evidence of statistical fluctuations. But the actual opportunity for the higher fluctuation of three miles an hour to occur is limited by the constraint of the one mile per hour walker. The fast boy at the front of the group can only keep on walking ahead if the other boys are also with him – ie he is dependent on them catching up if he is to reach his three mile per hour speed. Where there are dependent events, such as this, the opportunity for higher fluctuations is limited. Alex takes this knowledge back to the factory with him and sets about rescuing his plant.

IDENTIFYING BOTTLENECKS

Back at the plant, Alex and his team set out to identify which machines at the plant are the bottleneck resources. After talking to staff and walking around the factory, where there are big piles of inventory sitting in front of two main machines, the bottlenecks become obvious. Eighty per cent of parts have to go through these machines, and the team make sure that all such parts are processed on the non-bottleneck machines in priority to the other 20% of parts, by marking them up with a red label. The parts that don't go through the bottlenecks are marked with a green label. The result? Throughput increases. But the problem? Unfortunately, it doesn't increase enough to save the factory.

ELEVATING BOTTLENECKS

The next step is therefore to try and elevate the capacity of the bottlenecks. This is not easy without spending money, but observation shows that, at times, the bottleneck machines are sometimes still idle, despite the labelling system giving priority to the parts that have to be ready to go through the bottleneck machines. This is partly because workers are taking their breaks before getting the machines running again, and partly because they have left the machines unmanned because they have been called away to work on another (non-bottleneck) machine. Both of these absences result in the machines becoming idle. At this point, Alex learns an important lesson: an hour lost on a bottleneck machine is an hour lost for the entire system. This hour can never be recouped. It is pointless to leave a bottleneck machine unmanned in order to go and load up a non-bottleneck machine because there is spare capacity on the non-bottleneck machine anyway. It doesn't matter if it's not running for a bit. But it does matter in the case of the bottleneck. From this point onwards, the two bottlenecks are permanently manned and permanently running. Their capacity is elevated this way, along with another few changes that are implemented.

THE NEED TO ACCEPT IDLE TIME

At this point, Alex and his team think they have saved the factory, and then suddenly they find that new bottlenecks seem to be appearing. Parts with green labels on are not being completed in sufficient quantities, meaning that final assembly of the company's products is again not taking place, and orders are being delayed again (because final assembly of products requires both bottleneck and non-bottleneck parts). Alex calls Jonah in a panic and asks for help. Jonah soon identifies the problem. Factory workers are still trying to be as efficient as possible, all of the time. This means that they are getting their machines to produce as many parts as possible, irrespective of the number of parts that can actually be processed by the bottleneck. Jonah begins to explain, labelling a bottleneck machine as X and a non-bottleneck machine as Y. Some products may not need to go through X, he says, but that doesn't mean that workers should make as many parts as the machines can produce, just to keep the machine's efficiency rate looking good. Y parts should only be produced to the extent that they can be used in the assembly of finished goods, and the production

of these is constrained by their need for bottleneck parts too. Any excess Y parts will simply go to the warehouse and be stored as finished goods, ultimately becoming obsolete and having to be written off at a substantial cost.

As for those products that do need to go through X, they may, for example, go from Y to Y to X to Y (as there are numerous steps involved in the production process). But if the capacity of the first Y machine is far higher than the capacity of the next Y machine, and it processes excessive X parts, another bottleneck may look like it has appeared on the second Y machine because so many red labelled parts are being fed through that it never gets to process the green ones, which are also necessary for final assembly. Suddenly Alex realises that all machines must work at the pace set by the bottleneck machines, just like the boys on the hike that had to walk at the pace of the slowest walker.

Consequently, Alex realises that it is really important to let Y machines and workers sit idle when they have produced to the capacity of the bottleneck machines. By definition, they have spare capacity. It's not only wasteful to produce parts that are not needed or cannot be processed; it also clogs up the whole system and makes it seem as if new bottlenecks are appearing. This idea of idle time not only being acceptable but also being essential flies in the face of everything that is believed at the time and, yet, when you understand the theory of constraints, it makes perfect sense. A balanced factory is not efficient at all; it is very inefficient because different machines and processes have different capacities, and if machines that have spare capacity are working 100% of the time, they are producing parts that are not needed. This is wasteful, not efficient. As evidenced in the novel, inventory goes up and throughput goes down. Alex is quick to resolve the problem and get things running smoothly again.

THROUGHPUT AND JUST-IN-TIME

Given that producing excess inventories both pushes costs up and prevents throughput, it becomes obvious that throughput accounting and just in time operate very well together. This becomes clear towards the end of the novel when UniCo secures even more orders by reducing its delivery time dramatically. It is able to do this by adopting some of the principles of just-in-time.

First, Alex reduces batch sizes substantially. For those unfamiliar with throughput accounting and just-in-time, it can be hard to get past the idea that if batch sizes are halved, financial results may still improve. The novice believes that if batch sizes are halved, costs must go up, because more orders are needed, more set ups are needed, more deliveries are needed, and so on... and surely these costs must be high? But the fact is – as proved in the novel – inventory costs are also halved and, even more importantly, lead time is halved, which in this case gives UniCo a competitive advantage. Throughput increases dramatically because of increased sales volumes. These increased sales volumes also led to a significantly lower operating cost per unit, which, along with the reduced inventory costs, more than makes up for increase in the other costs. Given that there is spare capacity for all of the non-bottleneck machines

anyway, if the number of set ups for these is increased, no real additional cost arises because there is idle time. As Jonah says: ‘An hour saved on a non-bottleneck resource is a mirage.’

CONCLUSION

It is not possible, within the space of a few pages, to convey everything that The Goal has to say. To think that I could do so would be an insult to the authors of this 273-page novel. Nor is the theory contained within the novel beyond questioning and criticism; but this article was not meant as a critique.

Hopefully, however, I have told you enough to convince you that this book is worth reading should you have a couple of days to spare sometime. I haven’t, after all, told you the ending... Also, you should now have an understanding of the background to my second article, which you will find in the next issue of *Student Accountant*.

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