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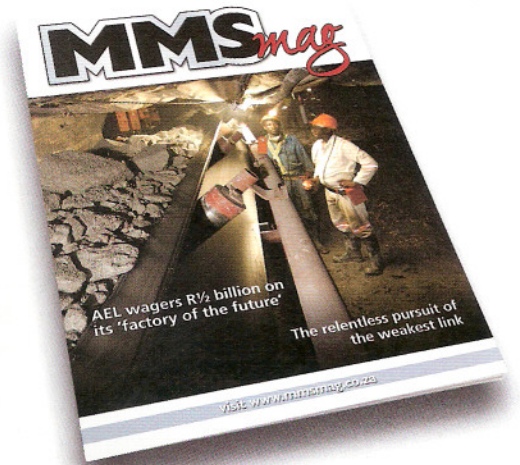
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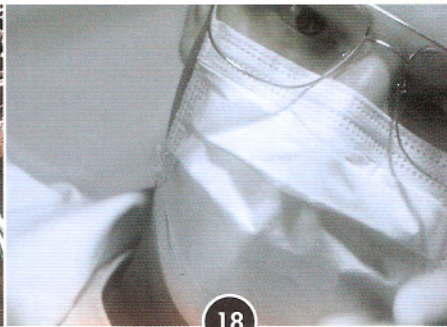
**AEL wagers R½ billion on
its 'factory of the future'**

**The relentless pursuit of
the weakest link**

MMSmag



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IN a country where our industry is largely driven by Mining and Metals, the trend of offshore manufacturing that hit the US and European Companies in the nineties had very little impact on our industrial segment. Our industry has largely benefited from this due to the increase in demand for resources by China and India.

During this period in the nineties I attended several conferences in the US where the common thread throughout was the question of survival of US manufacturing with the imminent threat of cheaper offshore contract manufacturing. I recall at the time visiting a US electronics manufacturer whose board gave it an ultimatum: You either re-engineer your operation to become cheaper, more flexible and attuned to client requirements, with higher quality standards, or we close you down and move our manufacturing offshore. This manufacturer took up the challenge and, with collaboration from employees, re-engineered their business through automation, process optimisation and employee training and reallocation programs. They have remained in business and have become a truly world class operation. It took them three years to achieve this.

Our main feature company this month is AEL, who, faced with a similar threat, also opted for the challenge of re-engineering their business to keep their local operation competitive. We thank AEL, and specifically Dr Graham Edwards, for sharing their journey with us. In the current corporate environment in South Africa most companies would have opted for the easier alternative, which makes this story all the more inspirational. AEL made extensive use of the Theory of Constraints, and in our second feature we bring you an interview with Alan Barnard from the Goldratt Group Africa which provides some insight into the practice.

As always we welcome your thoughts and comments on any of the articles in this issue.

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AEL wagers R¹/₂ billion on its 'factory of the future'

For as long as anyone could remember, AEL had been making a tidy packet supplying local mines with explosives. Then, four years ago, the Chinese arrived on the scene and turned the market on its head. The choice, Dr Graham Edwards told his board, was stark: we reinvent ourselves or we shut up shop. **By Tony Rattey**

"THINGS don't happen very quickly in the explosives business."

Graham Edwards should know. He heads up AEL, which has been making commercial explosives for the past 111 years. And its main product, the capped fuse, has remained pretty much unchanged for the past 40.

The truth is, until a few years ago, AEL was in a comfortable position. While it held only a five percent share (by revenue) of the world explosives market, it was the dominant supplier of initiating systems. There were two reasons for this.

"We could close the factory down, open an agency and buy from the Chinese. Alternatively, we could find a way of becoming a more competitive producer. That's the route we opted for."

Firstly, the biggest buyers of explosives are open-cast mines, which would typically place up to a ton of explosives and a single detonator in each blasting hole. South African mines, which are mostly deep, narrow-reef operations, use only about a kilogram of explosives per hole – and a detonator in each. So the demand for initiating systems – the technical term for detonators – is significantly greater in countries like South Africa than those where surface mining is more prevalent. It's hardly surprising, therefore, that AEL's output of more than 130 million detonators a year outstrips that of the two Australian gorillas that dominate the world explosives market: Orica and Dyno Nobel.

The other reason is AEL has been able to capitalise on these volumes, sustained over decades, to perfect the product. The capped fuse might be an old-fashioned detonator, but as AEL makes it it's also wonderfully reliable and cost



Dr Graham Edwards

effective – so much so that the barriers to entry for new competitors were virtually insurmountable. The company had a cash cow and was milking it.

Then things changed, as they tend to – even in the explosives business.

Unable to better AEL's capped fuses, rival manufacturers developed a new initiating system: the shock tube. This new-age detonator provides mines with better, quicker and more precise blasting, but it comes in at twice the price of a capped fuse. Edwards and his team took note of the threat, and developed their own range of shock tubes. But when the market settled at a 90 : 10 split in favour of the traditional product, it looked as if there was still life in the old cash cow.

Enter the Chinese.

Edwards knows he is not the first CEO to complain that the Chinese upset his business model, nor will he be the last. He is disappointed, though, that the Government has not given AEL the protection he believes it deserves.

"Four years ago, when the Chinese shock tubes hit the South African market, it was at a price 30 to 40 percent

lower than our product and only 15 to 20 percent more expensive than our capped fuses. The market loved it, and you can't blame them for not caring that the Chinese government was directly subsidising the exports."

AEL appealed to the DTI's International Trade Administration Commission, arguing that the competition was unfair; that it was likely to undermine their market and cause the loss of up to 1 800 jobs; and that in the long run it would be detrimental to local mines which would suffer from the elimination of local suppliers. The appeal was rejected, and AEL faced a crisis.

"We had a stark choice," says Edwards. "We could close the factory down, open an agency and buy from the Chinese. Alternatively, we could find a way of becoming a more competitive producer. That's the route we opted for."

AEL's radical plan is to build the most sophisticated and efficient initiating systems plant the world has seen and to produce sufficient volumes to generate decisive economies of scale. While the aim is not to be the cheapest supplier of explosives and initiating systems, it does intend to dominate the high end of the market by virtue of superior quality, service and safety – all at an acceptable price.

The R500 million project is already three years into its forecast five-year lifespan. It is divided into three major phases, dubbed Bernice, Charlie and Denise (don't ask).

- Bernice, which carries a price tag of R80 million, entails the creation of a new facility for the automated manufacture of shock tube detonators. The plant consists of four major elements: the manufacture of detonator tubes, the manufacture of delay powder, the processing of primary explosives, and

"It's tough to take your medicine while heading on a downward curve; to commit half-a-billion in capex while losing market share; and to run three factories at once – building the one up from scratch, phasing the other two out, and at the same time managing all of the people implications of converting from a mainly manual process to an entirely automated one."



the assembly of the detonator unit. With a capacity of 50 million detonators a year, it has enabled the company to increase its output by 66 percent. This plant was commissioned at the end of last year.

- Charlize – even more expensive at R100 million – will be complete by the end of the year. The two primary objectives of this phase are to automate the assembly of the shock tube units and to commission sufficient machinery and equipment to double the capacity of the new plant to 100 million detonators.

AEL's big gamble is that it will achieve such a high level of manufacturing proficiency that its product will significantly outperform those of its rivals.

- Denise is the final phase of what AEL calls its "factory of the future". It involves the consolidation of all of the company's manufacturing activities within the new plant and the closure of its two other existing facilities: the original shock tube factory and the old

capped fuse plant. Running through until 2009, it also entails matching productive capacity with the demand for the new products – and, of course, terminating the most profitable line the company has ever had.

AEL's big gamble is that it will achieve such a high level of manufacturing proficiency that its product will significantly outperform those of its rivals. The demand will be sufficient to provide the economies of scale needed to keep the price competitive. And it will take other manufacturers at least five years to catch up, by which time AEL will be in a strong position to make its next move.

The company has created an optimised manufacturing facility by combining best-of-breed components from a variety of suppliers in a unique configuration. Optimisation will be achieved over the duration of the project, with the Theory of Constraints' drum-buffer-rope application used to modify the set-up as each step of the process changes the way the plant functions. The first step was the automation of the manufacture of the most complex part of the shock tube: the composite

delay element that ensures the precise timing of the blast. Then automation was extended to the other parts: the fillers, the powder pressers, the driers and the assemblers. The performance of each unit, in its own right, is carefully monitored. Buffer stocks are placed between each unit to accommodate varying through-puts and production interruptions. The Theory of Constraints identifies bottlenecks, calculates how many buffers of different sizes are needed and where they should be placed, and then manages the entire process through these buffers. Each machine is independently controlled by its own software, with a manual interface. Only when the entire chain has been optimised and all bottlenecks eliminated will all the links be integrated by means of an over-arching production system.

"What we are creating really is a state-of-the-art manufacturing facility," says Edwards; "there's nothing like this elsewhere in the world. Each component is the best we could find, and we've put these building blocks together in a unique way. When we finally integrate them, we will have the most

Edwards finds the balance between

Graham Edwards is a mechanical engineer who started his career at Anglo Vaal's Hartebeesfontein mine but left because he preferred design work to maintenance. He joined AECI's special-purpose machine design shop, which focused on innovation and problem solving, and he believed he had discovered engineering heaven.

Over the next 29 years his progress careened back and forth, taking in most areas of the business – production, maintenance, commercial, marketing, procurement, strategic planning and production planning. All the while he continued to study, notching up an MBA and a doctorate in strategic marketing. After 14 years he became a director of AEL and in 1999 was appointed managing director.

As an engineer, he relishes the challenge of creating a world-class production facility that will attain a level of automation unprecedented in his industry. But even more exciting, for him, has been the transformation of AEL's people into an effective workforce that can compete

globally no matter how the market changes.

"This has always been a wonderful company to work for. It's been like a big, loyal family. But the downside of this has been that it's lacked bite. I've tried to change that by making people more accountable. Today, in everything we do, we strive for Care and Growth. Care is the softer, fuzzy side of our culture. Growth, we believe, is not attainable unless we focus on the key issues and have the courage to confront poor performance (instead of being so polite about it!) and take personal accountability. The trick, of course, is striking the balance between stretching people so that they feel they're growing and becoming so demanding that they feel they're just numbers in a cold, heartless process."

Edwards believes that while the most tangible product of AEL's transformation will be an optimally functioning factory, the most important product will be an exceptional workforce.

"That's really what we're trying to

achieve – exposing our people to a tough business environment, so that they develop the vision to recognise solutions and the ability to execute them. It's this, even more than our manufacturing capability, that's going to enable the company to thrive in the medium to long term, no matter what the market throws at us."

AEL launched its Care and Growth change management programme 10 years ago, with the help of Schuitema Associates. It ran at a high level of intensity for three years, and has been sustained since then. An indicator of its success has been the full engagement of all employees in planning the transition to AEL's 'factory of the future', notwithstanding the layoffs that automation will bring.

Another indicator is AEL's exemplary safety record. The company consistently beats its total recordable injuries rate upper limit of 0.6, putting it solidly within the top quartile of chemical manufacturers worldwide.

automated and technically advanced plant of its kind."

The primary benefit, if Edwards is right, will be a marked improvement in the quality of the detonators – in their reliability and the precision of the delay time. This is a big deal for mines, as it affects the amount of explosive needed and the amount of rock broken – in other words, their yield.

Two things will combine to keep the price of the product down: the de-engineering (or simplification) of the manufacturing process and the huge volumes that AEL expects to sell.

The third factor expected to differentiate AEL's offering is service. This too is important to mines, which require a quick response to their orders for customised products because they maintain the smallest possible stocks of the hazardous explosives on site. While AEL manufactures only a few dozen basic product types, each is offered with a range of specifications (such as tube length). These add up to thousands of variants. In the past, it took the sales team two days every month to forecast the demand for each variant on a six-

month rolling basis. If the forecast was out, customers had to wait while the manufacturing process was rejigged to fulfill the order.

Service is a vital part of the business. In fact, the Theory of Constraints identified the market as AEL's primary constraint, and improved service is one way of overcoming it. Mines don't have magazines on their premises and are reluctant to hold explosives for longer than 48 hours. AEL therefore delivers its initiating systems on a twice-weekly roster and its bulk explosives daily. In most cases the delivery truck is given a precise 15 minute window during which it must arrive and offload its consignment. The company has a 99.6 percent record for on-time in-full delivery.

"By eliminating bottlenecks in our process we have massively simplified our forecasting and set new industry standards for service. We've improved the lead time to fulfill orders for specific product configurations, we have much better control of our stock levels, our forecasting is easier and more accurate, and our sales people have been freed up to spend more time selling."

Finally, the new shock tubes are expected to be safer and more reliable than competitive products, as a direct benefit of straight-through automation.

Edwards is confident that, two years from now, AEL will be in a position to take on the world.

Two things will combine to keep the price of the product down: the de-engineering (or simplification) of the manufacturing process and the huge volumes that AEL expects to sell.

"And we'll win. We will beat the best manufacturers on quality and we'll meet their production cost. Even with the subsidies the Chinese are getting today, I'm comfortable we can match their price – in fact, I believe we'll earn a premium for the superior quality and service we'll be offering."

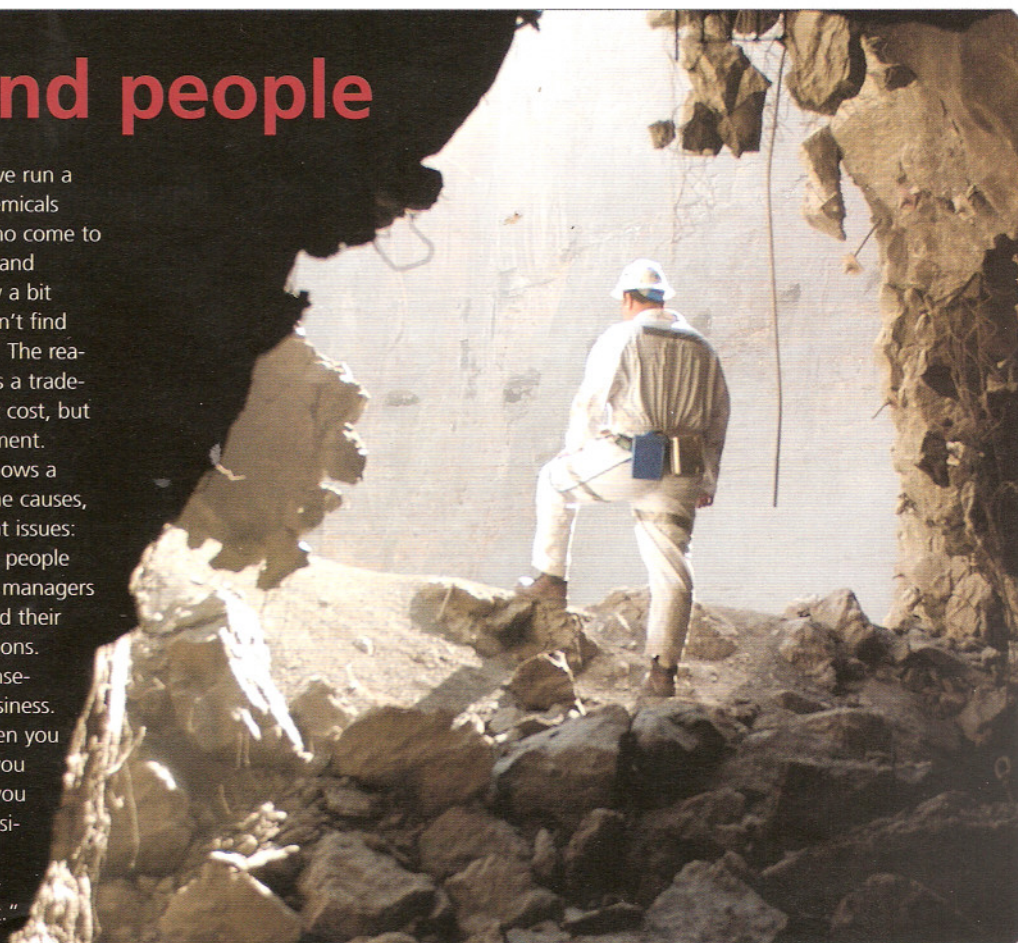
And how does he feel about slaughtering the company's cash cow?

"We didn't really have a choice. The kind of dilemma we were facing has, in many cases, brought companies to their knees. Rather than defend a dying product we decided to be proactive. We will

process and people

"We make explosives, yet we run a safer operation than most chemicals companies. We get visitors who come to inspect our safety procedures and systems, and they're invariably a bit disappointed because they don't find anything especially innovative. The reason is, we regard safety not as a trade-off against throughput or unit cost, but as a benefit of good management. Whenever our safety graph shows a wobble, and we investigate the causes, what we find are management issues: things like high staff turnover, people not being properly trained, or managers not having the courage to hold their staff accountable for their actions.

"We say that safety is a consequence of running a good business. And the best thing is that when you fix your management issues, you don't just get better safety – you get an all-round better-run business. That's why I often argue that we're blessed with a hazardous operating environment."



keep capped fuses going until they are no longer needed, but I believe the market will see value in the new product and will convert accordingly."

"The trick, of course, is striking the balance between stretching people so that they feel they're growing and becoming so demanding that they feel they're just numbers in a cold, heartless process."

Edwards is not blindly optimistic about the future. He fully expects new players to enter the market and for AEL to lose market share (until now, most potential competitors have been kept out by the popularity of the relatively cheap capped fuses). He is, however, hoping to retain 65 to 70 percent of the local market, while simultaneously growing offshore sales to spread the company's geographic risk and to reduce its dependence on the declining South African gold mines. He is projecting sales of about 120 million detonators a year, mostly to the

upper end of the market that is prepared to pay a premium for quality, and is happy to leave the more cut-throat segment to his competitors.

It is a high-stakes gamble that AEL has taken, and Edwards doesn't pretend that the past few years have been easy.

"It's tough to take your medicine while heading on a downward curve; to commit half-a-billion in capex while losing market share; and to run three factories at once – building the one up from scratch, phasing the other two out, and at the same time managing all of the people implications of converting from a mainly manual process to an entirely automated one."

But he has managed to convince his board that, by the end of its metamorphosis, AEL will be in a much stronger strategic position. It will have a modern product range with broad market appeal, and a more diversified customer base. It will have raised customer expectations with regard to product quality and delivery responsiveness,

making it more difficult for newcomers to compete. And it will have matured its production capability, giving it a sound platform for tackling the next set of market challenges.

One of these is expansion into foreign markets. AEL has already dipped its toe into areas such as Indonesia, South America and India. But shipping container-loads of high explosives to distant continents poses a whole new set of problems, which the company is in no immediate hurry to take on.

"Our whole philosophy for our renewal has been to plan it carefully and in detail, insofar as it's possible to predict what will happen. At the same time we've kept the process flexible, so that we can adapt our plans to cope with the hurdles – and the opportunities – as they emerge. We know what we're aiming for, and we're taking it step by step. It's not always comfortable, but it's a great adventure and it's making us a great deal stronger than we ever were."



Theory of Constraints

The relentless pursuit of the weakest link

Every CEO is striving for improvement. Most would settle happily for a consistent 2.5 to 10 percent a year. But Alan Barnard, director of the Goldratt Group Africa, says his experience is that the average South African company has the inherent potential to lift its performance by anything between 25 and 100 percent. In fact, a typical goal they commit themselves to when undertaking a consulting assignment is to help management deliver, within four years, net profit that is equal to current turnover. And with 90 percent of their fees contingent on meeting their goals you have to salute their confidence, if nothing else. **By Tony Rattey**

ELI Goldratt and his 40-odd consultancies around the world use the Theory of Constraints (TOC) to identify and address aspects of a business that are limiting its performance. The theory is based on the truism that a chain is only as strong as its weakest link, and the observation that most organisations function as a chain (or a network of chains). Fix the weak link and you have a stronger chain. It also follows that strengthening any link other than the weakest one will have no impact on the strength of the chain.

"The theory is based on the truism that a chain is only as strong as its weakest link."

Barnard goes further to claim that there are only four types of constraint that can hold a company back: cash, demand, supply and capacity. Identifying which is currently constraining growth, and how much potential can be unlocked, is the first in the five focusing steps of TOC – and is usually relatively easy.

"You only have to inspect a process with an open mind, and to speak to the people who are directly involved, to find out what's going wrong," he says.

Nor is the next step difficult: deciding how to exploit the constraint. This is done by finding ways of ensuring that none of the inherent potential of the weakest link is wasted – ensuring, for example, that the weakest link is never down, starved, blocked or over-producing.

The most challenging part of the entire process, in Barnard's experience, is



Alan Barnard – unlimited potential in most companies

step 3: implementing the decisions taken in step 2, and allowing nothing to stand in the way of this change.

"We call it full subordination – putting in place the new rules to better exploit the system constraint and, more importantly, removing all the old rules that prevented it in the past. There are a number of reasons why it's difficult to achieve. Mostly they are related to the compartmentalisation of the modern enterprise – the silos we all know so well. To function optimally the enterprise needs all of its compartments collaborating effectively. But invariably poor synchronisation, conflicting local objectives and measurements, different cultures and silo thinking, to name just a few, conspire against collaboration and, therefore, against system optimisation."

He quotes an example. It's a

manufacturing company whose constraint is in the market – demand for the product is less than its capacity. An order comes in for 200 units. However the production manager, who gets a bonus for minimising his unit cost, has ordered that batches shall be at least 1 000 units. So one of two things happens: the company either loses the order or it manufactures 1 000 units. The implications of the second option are that 800 unneeded units are kept in storage, and the factory loses 80 percent of its productive capacity while running the order – possibly creating the impression that there is a capacity constraint.

"Every system constraint is the result of an erroneous assumption – usually on the part of management – regarding the identification and unlocking of potential. In this case it was the assumption that the best interests of the company would be served by allowing the production manager to prioritise based on local cost optimisation rather than customer service and total cost optimisation."

Only when that is recognised and the rules are changed, says Barnard, is it possible to overcome the resistance to change and implement the decision taken in step 2.

"Before you change the rules you have to understand the conflict between local (divisional) and global (enterprise) optimisation. Unless you resolve this conflict you won't succeed in exploiting the constraint. But when you do get it right, and when you implement a new set of rules that are governed by the nature of the constraint, watch out! You could



"When the constraint is eliminated, it's obvious that a new link becomes the weakest in the chain. So it's back to step 1 from where the process is repeated, over and over again."

release more potential than you're ready for."

If after all of this the original constraint is still choking the process, step 4 says: "elevate it".

And finally, when the constraint is eliminated, it's obvious that a new link becomes the weakest in the chain. So it's back to step 1 from where the process is repeated, over and over again.

Drum – Buffer – Rope

A key aspect of TOC's methodology, in exploiting constraints, is called Drum – Buffer – Rope. When a production unit is identified as a constraint it becomes the designated drum – it sets the tempo at which the entire production chain operates. Buffers are established, potentially on either side of the bottleneck, to ensure that the unit is never starved of supplies and that its production is never retarded because the next unit downstream is not ready to receive its output.



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And the rope is the communication medium that feeds information (such as when to release materials based on buffer status) to all the parts of the system to ensure there is never too much and never too little. Drum – Buffer – Rope scheduling is the new set of planning rules for logistics, and buffer management comprises the new set of execution and feedback rules to focus and enable continuous improvement.

"We don't take on an assignment unless we're confident we can help them increase their profit to a level assumed in the past to be impossible."

The Theory of Constraints is often compared with other process improvement methodologies such as six sigma, lean, Just in Time and Total Quality Management. Barnard speaks highly of six sigma and lean, and insists TOC is not in competition with these approaches. In fact, the statistical rigour of six sigma in particular complements TOC in various stages of constraint identification and change implementation.

"My only criticism of six sigma is that it doesn't provide the single-minded focus of TOC. You can easily invest a lot of money and effort tackling a process deficiency that in fact is not a constraint. You might achieve the local optimisation

you're targeting, but have little impact on profits."

He quotes a study* conducted over a period of two years in which a US-based electronics manufacturer with 21 plants allowed its plant managers to choose one of three process improvement methodologies. Eleven opted for six sigma, four for lean, while six combined the best components of TOC, lean and six sigma (TLC). Using a carefully controlled survey method, the consultants tracked the impact of the three approaches on key metrics such as on-time delivery, warranty costs, customer returns, inventory reduction, cycle time reduction and scrap expense, as well as quality and cost savings.

At the end of the study, TLC had delivered 89 percent of the total cost savings achieved by the company's plants. Six sigma on its own provided seven percent, and lean on its own, four percent. In addition to a ten-fold return on their investment in TLC, management reported a variety of complementary benefits such as an "energised" staff. They called the combined programme "a complete success".

"The fact is, most CEOs don't realise how much unexploited potential there is in their business," says Barnard. "We don't take on an assignment unless we're confident we can help them increase their

profit to a level assumed in the past to be impossible. Nor does it stop there. There is no reason to assume that constraints are inherent, which explains why the best-performing companies are able to deliver consistently high rates of growth, year after year. The key to unlocking the inherent potential is to apply the five focusing steps of TOC to the organisation – and even to the supply chain as a whole – rather than to a specific part."

Here in South Africa there has been no shortage of takers. The Theory of Constraints boasts an impressive list of local believers, most of them mining and manufacturing companies, and many of which are applying the simple principles of TOC themselves. Transnet used TOC to increase the freight on its Mpumalanga – Richards Bay coal line by 30 percent, without employing any additional rolling stock. And with the founder motivated almost exclusively by the desire to leave behind a better world by putting the insights of TOC into the public domain, much of the Goldratt Group's efforts are devoted to helping NGOs and other not-for-profit organisations improve their operational efficiency and effectiveness.

** Continuous Improvement Trio, by Dr Reza M Pirasteh & Dr Kimberly S Farah, APICS Magazine, May 2006.*