

## BACK TO BASICS – A SYSTEMS APPROACH TO BETTER DECISION MAKING

**S. Macmillan<sup>1</sup> and P.J. Pretorius<sup>2</sup>**

<sup>1</sup>Barloworld Logistics, South Africa  
[smacmillan@barloworld-logistics.com](mailto:smacmillan@barloworld-logistics.com)

<sup>2</sup>Department of Engineering and Technology Management  
University of Pretoria, South Africa  
[pieter.pretorius@eng.up.ac.za](mailto:pieter.pretorius@eng.up.ac.za)

### ABSTRACT

Companies these days can be so caught up in the fad to implement the latest “world class”, continuous improvement programmes that some basic principles are ignored or left behind in the rat race. This article aims to take the reader back to the basics of systems theory to show how easy it is to lose sight of the goal. It will be demonstrated with a case study of a “world-class” operation that neglected the principles of systems theory and paid the price for it. It demonstrates how crucial it is to have the correct (integrated) performance measurement system to ensure that the goal of the organisation can be achieved.

### OPSOMMING

Deesdae is ondernemings so vasgevang in die dolle gejaag na sukses deur die implementering van die nuutste “wêreld-klas” kontinue verbeteringsprogramme, dat die basiese beginsels agterweë bly. Hierdie artikel neem die leser terug na die basiese beginsels van stelsel-teorie om te demonstreer hoe maklik dit is om die doel van die onderneming uit die oog te verloor. ‘n Gevallestudie van ‘n “wêreld-klas” operasie wat die beginsels van stelselteorie geïgnoreer het, word bespreek. Dit het die onderneming baie duur te staan gekom en beklemtoon weereens die belangrikheid om die regte, geïntegreerde metingstelsel in plek te hê wat sal verseker dat die doel van die onderneming bereik kan word.

---

<sup>1</sup> The author was enrolled for the MEng (Technology Management) at the Department of Engineering and Technology Management, University of Pretoria

## **1. INTRODUCTION**

Successful organisations will always share similar characteristics: a clearly defined goal, good performance measurement systems, and a bold approach to decision making and execution. Measurement systems are needed to demonstrate goal achievement and as such must be derived from the goal [1]. Measurements are also needed to support decision making over the short, medium and long term, with the aim of achieving short, medium and long term objectives in support of the goal. Most important however, is the actual achievement of the organisational goal, while at the same time meeting the necessary conditions imposed by stakeholders other than the shareholders. These necessary conditions include requirements such as satisfying market needs, operating within existing legislation, having a concern for the environment and society, as well as providing a secure and satisfying environment for employees and suppliers. Considering the above, the importance of having a clear goal is quite obvious for decision making in achieving the organisational goal. Goldratt [1] has shown that the goal of a for-profit company is to make money now as well as in the future.

The mission statement of a company provides one with more insight with respect to the specific goal and approach to goal achievement. According to King and Cleland [2] two (of seven) reasons why a mission statement exists, are (1) to ensure unanimity of purpose within the organisation; and (2) to specify organisational purposes and the translation of these purposes into goals in such a way that cost, time and performance parameters can be assessed and controlled. From the above, the link between the goal as stated in the mission statement and the organisational measurements can clearly be seen. At the same time, it is a well known fact that measurements influence behaviour [4], i.e. people act according to the way in which they are measured. Irrational measurements inevitably would lead to rational people knowingly behaving irrationally to satisfy irrational measurements. Considering the above, the measurement system of the organisation has to meet two critical requirements, namely (1) the measurement system must support the goal stated in the mission statement, and (2) the measurement system must cause the correct behaviour.

## **2. OBJECTIVE OF THE RESEARCH**

Many mission statements of for-profit organisations, do not explicitly state the goal of making money. Instead, overall goals such as being the lowest cost provider, having the biggest market share, having the highest quality product or service, or being world-class, are often substituted for the goal of making money. At best, some organisations will mention the maximising of shareholder wealth as a goal. The problem with omitting the explicit goal of making money now provides emphasis to its replacement, which in turn will dictate to a large extent the design of the measurement system, and thus human behaviour.

The objective of this research is to demonstrate the negative effects of “forgetting” the real goal of the organisation, and to explain how the resulting incorrect measurement system, decision making and human behaviour invariably lead to value destruction and job losses, instead of wealth creation.

## **3. RESEARCH METHODOLOGY**

The following methodology was used for the research:

- Basic organisational characteristics have been researched, based on the premise that an organisation can be explained by systems theory. These characteristics are:
  - Each system is constrained in its output, by either an internal or external constraint;
  - Local optimisation of system components does not necessarily lead to system optimisation;
  - Decision making and measurements at the local level must be linked to system level effects;
  - Cause and effect are often distant in space and time; Small changes produce big results, but the leverage points are often the least obvious.
- A case is analysed to demonstrate the effects when a systems approach is not taken.
- Deductive reasoning is used to explain the case as well as to predict how performance could be improved with the application of systems thinking in decision making.

## 4. BASIC SYSTEMS THEORY

### 4.1 The organisation as a system

*“There is a broad consensus that if we want to improve the performance of our organisation, we have to take a systems approach. You have to start with a broad base, and not take any one function in isolation”.* These profound words were spoken by Dr Eli Goldratt [3], as the introductory words on his GSP (Goldratt Satellite Program). However, despite the realisation that organisations should be viewed from a systems perspective, it seems as if it does not happen in reality, as is evident by the mistakes managers make. These mistakes can be explained by non-systemic thinking and decision making [4]. One possible explanation for this state of affairs is that the meaning of the systems concept is unclear in the minds of many managers, which necessitates the need to clarify the concept of the organisation as a system. This lack of understanding is confirmed by Ackoff [4] when it comes to the implementation of some well known techniques: *“Managers fail to diagnose the failures of the fads [e.g. TQM, benchmarking, downsizing, process re-engineering and scenario planning] they adopt; they do not understand them. Most panaceas fail because they are applied anti-systemically. They need not be, but to do otherwise requires an understanding of systems and the ability to think systemically. The perceived need to learn something new is inversely proportional to the rank of a manager.”*

Gharajedagi [5] defines five characteristics of an organisation as a system, i.e. openness, purposefulness, emergent properties, counter-intuitive outcomes and multi-dimensionality.

- An organisation is an open system, since it interacts with its environment and the behaviour of the organisation can only be understood in the context of its environment. The organisation is influenced by its environment and vice versa. Thus organisations making more money will not only create more wealth for their shareholders, they will also influence the society in which they operate in terms of job creation and infrastructure that can benefit society.
- In the introduction it has already been stated that organisations exist for a reason. For-profit companies share a generic goal, namely that of making more money now as well as in the future, whereas the owners of a for-cause organisation have the sole right to

determine its goal. This research limits itself to for-profit organisations. However, the principles can be transferred to for-cause organisations as well.

- An emergent property is a characteristic of a system which exists at system level but not at the component level. Profit is the result of all the components (functions) in an organisation working together; no single function is responsible for profit. Therefore net profit, a function of revenue and cost which does exist at component level, is an emergent property of a for-profit organisation. It is thus important to manage interactions, since it is interaction between components that lead to emergent properties.
- Counterintuitive outcomes are the result of not understanding the relationships between components and how a cause may lead to different effects. Counterintuitive outcomes imply that an action is taken with an expected outcome, however, the opposite outcome is achieved. An example would be the reduction of cost to increase net profit, but with the actual result (counterintuitive outcome) of cost going up due to quality going down when costs are cut.

The above characteristics of the organisation as a system imply that to manage an organisation well, a profound understanding is required of complex systems to make good decisions that will influence people behaviour that will ultimately take the organisation closer to its goal.

#### **4.2 All systems are constrained in their output**

One of the best known analogies for an organisation as a system is a chain. A chain is only as strong as its weakest link, and no chain possesses infinite strength. In a similar way no for-profit organisation can produce infinite profits, therefore it is to be concluded that all organisations are constrained in their output, and must have at least one constraint [7]. The constraint of an organisation is defined as that one thing which limits the goal achievement. It can either be internal to the organisation (i.e. a physical resource) or it can be in the market (i.e. there is less demand than supply). Not only does the constraint determine the overall income (since no more volume can be sold than what the constraint can handle), it also determines profitability [11], lead times and inventory levels.

Constraints of organisations are not limited to physical constraints, such as a scarce resource, limited raw material supply or lack of market demand. Constraints also exist as policy constraints, where goal achievement is limited by management policies which are not aligned to the organisational goal. An example would be a policy not to reduce prices in a constrained market situation, where sales may be lost to a price sensitive market even though large amounts of inventory and capacity exist.

The important issue is that in order to make good decisions, one needs to know where the constraint is and focus the management efforts on the constraint. Even when constraints are ignored, will they still exist and determine the wellbeing of the organisation.

#### **4.3 Local optimisation is not equal to global optimisation**

Having an understanding of organisational systems constraints, allows one to appreciate the process of optimising the system. Only if the weakest link of a chain is improved, will it improve the overall strength (emergent property) of the chain. Improving a non-weakest link

will add weight, but not strength. Similarly, making more money is only possible if the organisational constraint is improved and only cost added if a non-weakest link is improved. Many techniques are focused on eliminating cost, which translates to taking weight of all links. In itself, eliminating waste is not bad; however there is a limit to waste reduction. If one is very successful at eliminating waste, one would end up with a chain with links of equal strength and weight. In a perfect world, this is the ideal. However, since we still have to deal with uncertainty and statistical variation, optimising an organisation to be perfectly balanced will lead to total chaos, as each resource would turn into a constraint, while uncertainty will make it impossible to predict where the next problem would be. Such a situation will lead to what is normally known as “fire fighting”. The effects of fully balancing an organisation are well documented, the best probably being described by Goldratt [6].

#### **4.4 Decision making and measurements must be integrated on all levels**

Since an organisation and all its components should share a common goal, decision making and measurements on any level of organisation must therefore support the common goal of the organisation. Thus if a resource is utilised, it can only be a good decision if the organisation makes more money. If a resource is utilised more than what is required for goal achievement, it should rather be idle. The distinguishing factor whether a resource may have idle time or not depends on whether the resource under consideration is the constraint or not. Thus, maximum utilisation seems to be a good measurement for a constraint, as an increase in utilisation will lead to making more money. Conversely, a non-constraint should only be utilised to the extent that it will keep the constraint busy, and no more. Therefore it seems as if maximum utilisation is not a good measurement for a non-constraint. Of utmost importance is therefore to have a measurement that indicates where the constraint is. Without knowledge of where the constraint is, making decisions is like playing Russian roulette with only one chamber empty. There is a very good chance of getting it wrong.

In recent times techniques like the Balanced Scorecard have become very popular to do exactly this: to integrate measurements (and decision making) at all levels in support of the organisational goal. It is however questioned whether all the relationships between the different measurements on the different levels have been properly researched from a systems perspective and whether all the relationships of cause and effects are properly understood. It is however a topic for future research and will not be addressed further in this paper.

#### **4.5 Cause and effect are often distant in space and time**

Frequently it is assumed that cause and effect are close in space in time. This implies that the effects of actions would be seen immediately and the relationship between cause and effect can be explained. However, though it may be true in some cases, it is definitely not true universally. A good example would be the decision to cut costs. Many times when costs are cut the training and maintenance functions are targeted first, since they are not directly contributing towards revenue. Once the costs of these activities are cut, reduction in cost with a resulting increase in profit is most probably experienced immediately. In the long run however, due to lack of training and maintenance, the quality of the product or service will tend to decrease, resulting in revenues, profits and market share dropping.

In an organisation it translates to the place where symptoms are seen which is not necessarily the source of the cause. By cause is meant the interaction of the underlying system that is most responsible for generating the symptoms and when recognised and changed, could lead to significant improvements [8]. A big problem with understanding this system characteristic is that there is a major difference between the complex reality of the organisation as a system and the way we think about it [*op cit*]. We therefore need to look for causes of problems within organisations in a very different way.

#### **4.6 Small changes produce big results, but the leverage points are often hidden**

This system characteristic is best illustrated again using the chain analogy. Huge changes in non-weakest links will definitely not improve the strength of the chain. However, focused, even small improvements will have immediate visible results provided it is made on the weakest link. The classical PQ problem described by Goldratt [1] explains this principle perfectly with a worked example, where two changes to a production system are proposed. The first proposed change involves huge time reductions in product processing times, with obvious benefits such as reduced capacity requirements and obviously reduced product cost. The second proposed change proposes process time on one resource to be reduced by a very small margin, whilst the time on another resource increases by more than the decrease on the first resource. This leads to an overall increase in processing time, with a resulting increase in product cost as well. What is not obvious is that the first proposal is reducing time on already non-constrained resources, which will only render them with more capacity. Because the constraint is not addressed, everything else (including volume sold) remains the same. The second proposal however, proposes the small time reduction on the constraint, which will have an immediate effect on volume sold. The resource whose time is increased is a non-constraint with sufficient capacity to handle the increase in time.

### **5. CASE STUDY**

#### **5.1 Introduction**

A brewery has been chosen to demonstrate the impact of ignoring a systems approach in managing the organisation. Breweries operate in a very dynamic environment because of the seasonality in sales. Also, by nature a brewery is a combination of a high-volume batch (brewing) and continuous-batch (packaging) processes which adds to the complexity of making good decisions. The data obtained for this study is from a local brewery that wishes to stay anonymous.

#### **5.2 The basic process**

The brewing process converts water, malt, a starch source and hops into wort, by milling, mashing and boiling the grain ingredients. This process takes about three hours and is carried out in the brew house. The wort is then cooled and sent to fermentation vessels. Yeast is added and allowed to ferment for a minimum period of 14 days. The fermentation process converts the starches and sugar into alcohol and CO<sub>2</sub>. After fermentation the beer is allowed rest for a period from 4 to 10 days. The beer is then filtered using an inert product, called Kieselguhr. After filtration the final quality checks will be conducted and the beer blended with de-aerated water. These final quality checks are conducted in what is referred to as the

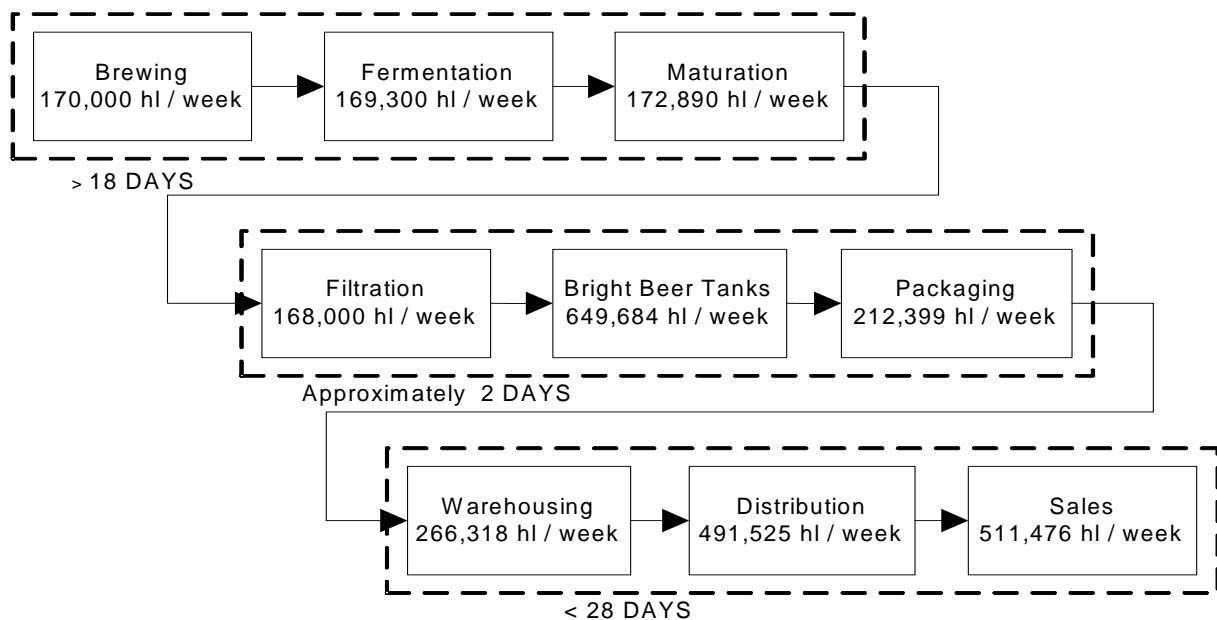
bright beer tanks which forms the last storage buffer before the packaging operation. Within each process the total volume is handled as a single batch. However, despite the fact that a single batch is processed at a time, the total volume of beer is very large compared to the ultimate finished product, that the process is considered a high volume batch process. Also, due to the nature of the process, the process batch and transfer batch are the same size, meaning that the whole order quantity is processed together before it gets sent to the next process for further processing [9].

The packaging process which draws its beer supply from the storage tanks and packaging material from the raw material supply system. There are four main processes in the packaging of beer: filling, crowning and seaming, pasteurisation and labelling. Other supporting processes are palletising and depalletising, unpacking and packing of returnable cartons and plastic crates and full bottle inspection. The filling is conducted in a rotary machine which inserts filling tubes into the bottles or cans after which the container is filled to the correct fill height. The next step is to seal the containers. With bottles it is done using a crown cork in a crowning machine while cans are closed up on a seamer. The crowning machine and seamer are part of the fillers. The product may be biologically clean at the time of filling, but minor infection with bacteria, brewery yeast, or wild yeast would cause a rapid breakdown of the product. Therefore, pasteurisation is the process used to stabilise the product. The final processes for bottles are labelling and palletising. Cans are shrink wrapped, usually in combination of six, after the pasteurisation process. The whole packaging operation is a continuous-batch process. Some would refer to this type of operation as a line operation. A continuous-batch (or line) process is a structure which is generally employed when a business has a relatively stable line of products, each of which is produced in periodic batches, either to customer order or for inventory. Products pass through the same sequence of operations. However, the defining difference between high-volume batch and continuous batch would be that unlike high-volume batch, the process batch in continuous-batch may be very large, however the transfer batches are very small, usually one unit only.

The production-planning problem is created by the fact that a high-volume-batch process (brewing) feeds into a continuous-batch process (packaging). The lead time for a brewing batch is about 18 days whereas the lead time to package that batch is just more than one day. A new brewing batch is started as many as two or three times a day, depending on the brewing schedule. The storage/buffer management between these two operations is therefore absolutely critical and is further complicated by a push system (brewing) feeding into a demand-pull (packaging) system. The brewing process is a make-to-stock where large batches of beer are produced and stored in a large number of large vessels to ferment and mature. The brewing schedules are created by using forecasts, which follow the characteristics of a push system. The packaging operation is a make-to-order operation, where different package types are scheduled for production on a weekly basis. The schedule is determined by orders accumulated in the previous week and loaded against the available packaging lines. The packaging schedule is developed by scheduling backwards from the last packaging process and converges to the matured beer inventories. Here the push from brewing meets the pull from customer demand. Taylor and Bolander [10] refer to this type of scheduling as outside-in mixed-flow scheduling logic.

### 5.3 The physical constraint in the brewery

Goldratt [6] states that it is easy to identify and exploit a capacity constraint in a factory. It is however difficult to subordinate to it. A physical constraint will mostly be visible, i.e. there will be a great deal of work-in-process immediately before the constraint process. Alternatively, the operators will immediately, without thinking, be able to tell you which machine causes the most down- or waiting time. Speaking to the operators in the brewery you quickly find that the filtration operation is the “problematic operation” causing most of the downtime. However, a more accurate method was used by analysing the rated capacities of the processes which confirms the suspicion of the operators. The internal capacity constraint in the brewery under question is in the filtration operation (see Figure 1), where capacities are expressed in hecto-litres per week (hl/week). Even though filtration is the obvious capacity constraint of the brewery, other processes such as fermentation and maturation are not far behind and can, through improper production scheduling, also become constraints in the system.



**Figure 1: The capacity of processes in the brewery**

Despite this seemingly obvious constraint, some of the actions that have developed over the years are:

- The packaging operation is the most complex and costly it therefore receives the most attention.
- For the same reason as above, the scheduling of the brewery is determined by the packaging operation.
- Filtration had to start working weekends to ensure that there was enough beer ready for packaging on Monday mornings, because of lack of sufficient capacity.
- Benchmarks, based on product cost measures have been developed between the different breweries and processes in the breweries, resulting in larger batches than necessary in order to reduce setup time and cost.



It is thus clear that the real constraint of the brewery is the fact that the physical constraint is ignored. The real constraint is thus on the policy/behavioural level. Being ignorant of the real constraint and following erroneous policies that lead to irrational behaviour invariably must lead to negative effects for the brewery. According to Noreen, Smith and Mackey [7]: *“There really is no choice in the matter. Either you manage constraints or they manage you. The constraints will determine the output of the system whether they are acknowledged and managed or not.”* The negative effects of ignoring the real constraint are discussed in the next section.

#### **5.4 The negative effects/symptoms experienced by the brewery**

Some of the symptoms that have been observed as a result of the fact that the brewery has chosen to ignore the physical constraint of the system are:

- The beer as scheduled is not available to be packaged. Despite all the packaging raw materials being ready according to schedule, the packaging lines still have to wait for beer to be filtered and inspected in the bright beer tanks. This has resulted in numerous packaging “over-runs” into Saturday and Sunday to complete the week’s packaging programme, which naturally necessitates overtime payment.
- As mentioned earlier, filtration had to start working weekends to ensure that there was some buffer stock in the bright beer tanks for a Monday morning. This is a luxury that would not be possible in the peak sales season when both packaging and filtration operations are scheduled to produce 7 days a week.
- The focus in brewing has always been firstly on quality, to ensure that the large batches of beer do not have any defects and have to be dumped. Brewing will rather produce less beer at a better quality than produce a higher volume with some quality defects that may not even be detected by the customer. Even though filtration has more of the characteristics of a line operation, the performance measures of brewing apply. The result is that the focus is not on the high efficiency of the filters, but on the quality of beer produced. This is evident from the fact that the efficiency in the filtration operation has always been below accepted norms.
- The overtime and low throughput on the constraint has led to a lower allocation of volume to this brewery than to other breweries in the group, which in turn drives up the product cost (Rand/hecto-litre), which is a key performance measurement for the brewery. This vicious circle, combined with low sales volumes, has actually culminated in the closure of packaging lines and the retrenchment of people.

### **6. DISCUSSION**

#### **6.1 Introduction**

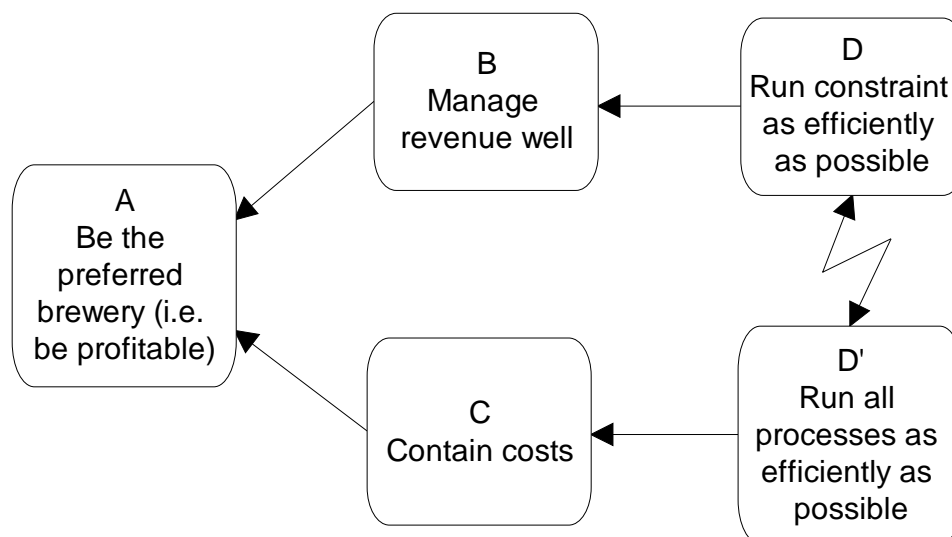
The irony of the whole situation is that the brewery has received many accolades as being a “world-class” brewery in the past and continues to do so. It was used as a benchmark for all the other local breweries and even other, outside companies. However, on closer examination of the operations, it is soon realised that there is an underlying conflict in the brewery as a result of the silo approach, i.e. the optimisation of each separate process.

## 6.2 The real constraint in the brewery

Although the capacity constraint in the brewery is quite obvious, there is another, more limiting constraint in the form of a policy. The underlying policy in the brewery is that the sum of local optimisations will lead to a global optimum. In other words, improvement in efficiencies in the brewing operation, in the packaging operation and in warehouse and distribution will lead to an overall improvement for the brewery. Apart from the quality improvement initiatives, most of the efforts in the past have been in isolated pockets aimed at either producing larger batches in brewing, increasing the operating efficiency of the various packaging lines or reducing the turn-around-times of vehicles on the site. Although most of these continuous improvement initiatives were very successful in terms of stated objectives, it never resulted in a significant increase in volume allocated to the brewery.

## 6.3 The resulting core conflict or the real cause for problems

The core conflict within the brewery is illustrated in Figure 2. For the brewery to be profitable, the main objective becomes the need to be the preferred producer in the group. The preferred producer will have the advantage of producing the largest share of the planned volume in the group. To be the preferred producer, the brewery not only has to manage costs well, but also manage revenue well. Each of these requirements has an underlying prerequisite action which is in direct conflict with each other. To manage the revenue of the brewery well, according to systems theory, the constraint has to be run as efficiently as possible (and all other operations subordinated to it). To manage the costs of the brewery well, all the processes have to be run as efficiently as possible. The result is a compromise between cost reductions and increased volumes by the managers of the different operations, e.g. even though a concerted effort is made in the packaging line to save costs during the week, all the effort is negated since they have to incur overtime to run on the weekend to make up for filtration not being able to supply the beer in time.



**Figure 2: The core conflict of the brewery**

At first it looks as if the conflict cannot be resolved; it is the classic managerial conflict that exists in almost every factory throughout the world i.e. local vs. global optimisation. However, from a systemic view, a few key assumptions can be verbalised from the conflict diagram. Assumptions are the reasons why a necessary condition or prerequisite exist:

- The first underlying assumption is found between the prerequisite D' and necessary condition C. It is read as follows: In order to contain costs, we have to run all processes as efficiently as possible since the higher the efficiency of all the processes are, the more the cost of the brewery will be contained. This is only true if all resources have equal capacity, there is no statistical variation that causes some resources to become constraints temporarily, and everything produced was sold. The biggest problem with this assumption is that lowest cost is normally expressed as cost per unit and not as total cost. It is therefore assumed that product cost (Rand/hecto-litre in the case of the brewery) is a good measurement to indicate whether costs are contained. However, if efficiency is increased, volume produced will increase, therefore despite the fact that cost per unit goes down, total cost will increase. The reality for the brewery was that even though they did achieve higher efficiencies it was still not enough to stop retrenchments and packaging line closures.
- The second underlying assumption relates to the first one. Reality has shown to the schedulers in the brewery that it is not possible to run all processes as efficiently as possible. If one then has to choose a resource to be most efficient all the time while the others can be less efficient, choose the process that is most expensive. In that way costs, at least in the mind of the schedulers, will be contained best. Over the years a culture has developed believing that the packaging line should never stand still since it was the most expensive part of the process; it is the same as pouring money down the drain! The schedulers in the brewery are then also encouraged to ensure that the production runs are as long as possible and the changeovers from one brand or packaging to another are minimal, to increase efficiency and reduce cost/unit. This resulted in either finished product lying in the warehouse without being sold or packaging lines having to stop since there is not enough filtered beer available for their production plan due to the real constraint.

It is thus clear that the decision making within the brewery was governed by the measurement system placing emphasis on high efficiencies of all resources, especially the most costly packaging line, and product cost. The breakthrough idea that will eliminate the conflict in the brewery is to change the performance measurement system. The processes making up the value chain of the brewery should not be measured on their contribution to higher efficiency and lower Rand/hecto-litre, but rather on their contribution to the income of the brewery, since most of the cost of the brewery is fixed, irrespective of volume. Income can thus be optimised if the constraint is managed well, and all other resources managed in such a way that it supports the constraint all the time.

#### **6.4 The application of systems theory in the brewery**

The application of a more holistic systems view of the brewery value chain relies on two things; the performance measurement system of the brewery and secondly the scheduling practices. The underlying assumptions between D and B are correct since they can be justified by systems theory principles, discussed in Section 4. A paradigm shift is required away from the traditional view that packaging efficiencies determine the income of the brewery to that of

the constraint (filtration) determining the income of the brewery. By implication filtration efficiency becomes the most important measure of income in the brewery. It will also differ from brewery to brewery, because the constraints in the other local breweries might not be in filtration, but in another process, even packaging. Another problem is the drive for packaging efficiencies is rooted in company-wide measure to compare one brewery to another.

The second change that needs to be made is in the scheduling system. A scheduling system should be considered where the constraint (filtration) is the departure point of the schedule of the whole system, protected by a buffer (probably a time buffer) and also determines the release of raw materials into the system. The functioning of such a system is described extensively by Goldratt [1] and is known as drum-buffer-rope scheduling.

An exercise was conducted by taking an existing packaging plan and applying the above proposed changes to the schedule. This was done to prove that better performance could be achieved if the above two changes were made. In the original plan the packaging operation was scheduled to produce 172 000 hl in the particular week. The schedule was determined in the traditional way of allocation to the various packaging lines, trying to minimise brand and packaging changes and start-ups. The filtration plan was then derived from the completed packaging plan. The plan assumed that both operations had to work 7 days a week, 24 hours a day, which would be the case in the peak period. The best schedule for filtration could only manage 157 600 hl. There was already a deficit of 15 000 hl in the plan, without taking poor efficiencies, breakdowns etc. into consideration that would invariably occur in the execution of the plan. The schedule was then changed by scheduling filtration first, by establishing a plan for filtration with long runs, minimum number of changing over and start-ups. The result was that filtration could then produce 168 000 hl per week; an improvement of 10 000 hl for that specific week. The packaging lines will be able to cope with this volume easily. The implied plan called for 13 more start-ups or brand changes on packaging with the largest reduction in process batch size of 1090 hl on one particular packaging line. Despite the increase in number of batches it is clear that the impact on the packaging schedule is insignificant.

System management principles dictate that the constraint of the system needs to be exploited and all other operations subordinated to it [1]. This implies that filtration will be run as efficiently as possible, and also be the key operation determining at what time a specific product is packaged and shipped from the brewery, as well as when the brew should start. If there is no beer to package, the packaging lines need to be idle. They should however be extremely flexible to do short runs and more brand and packaging changes. This alone will require an enormous change management intervention in the brewery. The filtration operation will also have to come to the party and improve their efficiencies to world-class standards to protect the income of the plant, because “a minute wasted at the constraint is a minute wasted for the system” [6]. Small changes here will produce big results.

## 7. CONCLUSIONS

The brewery is a good example of a “world-class” operation that neglected the principles of systems theory. Even though the performance against identified measures was accepted as good, and even set as benchmarks for others to try and achieve, the price was paid for not considering the real constraint of the system. The brewery has to go back to the basic truths

that all systems are constrained in their output, the sum of local optimisations does not achieve the global solution, and that decision making should be integrated at all levels.

The brewery was a specific case to demonstrate how wrong measurements could lead to negative outcomes. Despite the fact that every decision maker has had good intentions to achieve the organisational goals, the flawed assumptions were the real cause for the bad performance. These flawed assumptions are many times established through experience (what has worked in the past), habit (we have always done it that way), peer pressure (everybody else is doing it) and education (the academics must be right, they are the people that know). This goes to show that whenever assumptions are made, their validity should be checked first, as making an assumption does not change the reality of how systems function. If the wrong assumptions are made, counter-intuitive outcomes are the inevitable result. Also, the system principle was demonstrated that cause and effect many times are distant in space and time. The retrenchment of people was the effect of the much-earlier wrong assumption of local optimisation that the most costly investment should be run as efficiently as possible to achieve global optimisation. It may even be possible that some people, through their decisions caused their own retrenchment without even knowing it.

A constraint should not be viewed as something negative. It should also not be ignored or wished away. Rather, having a constraint is a reality of all systems which should be managed pro-actively. It should be the point of management focus as it controls the performance of the overall system. Focus means that most management time is spent on making decisions regarding the constraint. That allows big performance improvements with very small changes. Another key learning from applying systems theory to the case is that even though a part of the system may change and do the right things, it may have little or no effect on the overall system. A far more serious challenge is to change the bigger system. Even if the brewery were to change its decision making to what is proposed, they will be penalised by the larger system since the measurements for the larger would not have changed. Not only should the measurement system be integrated at all levels within an organisation, it should be done at all levels of the system of which it is part.

## 8. REFERENCES

- [1] **Goldratt, E.M.** 1990. "*The Haystack Syndrome*", The North River Press, Croton-on-Hudson, NY, 262 pages.
- [2] **Pearce, J.A. II and Robinson, R.B. Jr.** 1988. "*Strategic Management*", 3<sup>rd</sup> Edition, Irwin, Homewood, IL, 988 pages.
- [3] **Goldratt, E.M.** 1999. "Operations Management", *Goldratt Satellite Program*, 3 March 1999.
- [4] **Ackoff, R.L.** 1999. "On passing through 80", *Proceedings of the Russel L Ackoff and the Advent of Systems Thinking Conference*, Villanova University, PA, 4 - 6 March 1999, pp 32-36.
- [5] **Gharajedahi, J.** 1999. "*Systems thinking: Managing chaos and complexity*", Butterworth-Heinemann, Boston, MA, 302 pages.
- [6] **Goldratt, E.M. and Cox, J.** 1992. "*The Goal : A Process of Ongoing Improvement*", 2<sup>nd</sup> Revised edition, The North River Press, Croton-on-Hudson, NY, 333 pages.

- [7] **Noreen, E., Smith, D. and Mackey J.T.** 1995. “*The Theory of Constraints and its implications for Management Accounting*”, The North River Press, Great Barrington, MA, 187 pages.
- [8] **Senge, P.M.** 1990. “*The Fifth Discipline - The Art and Practice of the Learning Organization*”, Doubleday, New York, NY, 424 pages.
- [9] **Hill, T.** 2000. “*Manufacturing Strategy: Text and Cases*”, 2<sup>nd</sup> Edition, Palgrave, Hampshire, 569 pages.
- [10] **Taylor, S.G. and Bolander S.F.** 1994. “*Process Flow Scheduling – A Scheduling Systems Framework for Flow Manufacturing*”, APICS, Alexandria, VA, 168 pages.
- [11] **Garrison, R.H. and Noreen, E.W.** 1997. “*Managerial Accounting*”, 8<sup>th</sup> Edition, Irwin, Boston, MA, 859 pages.